

RICE UNIVERSITY

**Landscape Formation Processes and Archaeological  
Preservation in the Ethiopian Highlands: A Case Study from  
the Lalibela Region**

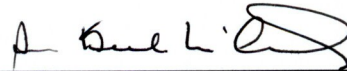
by

**Brian Clark**

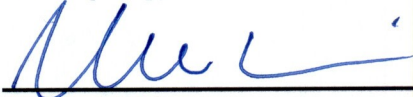
A THESIS SUBMITTED  
IN PARTIAL FULFILLMENT OF THE  
REQUIREMENTS FOR THE DEGREE

**Doctor of Philosophy**

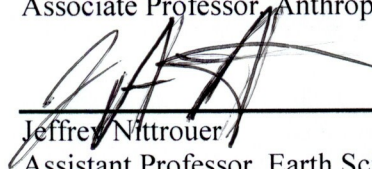
APPROVED, THESIS COMMITTEE



Susan K. McIntosh, Chair,  
Herbert S. Autrey Professor,  
Anthropology



Jeffrey Fleisher  
Associate Professor, Anthropology



Jeffrey Nittrouer  
Assistant Professor, Earth Science

HOUSTON, TEXAS  
November 2015

## **Abstract**

"Landscape Formation Processes and Archaeological Preservation in the Ethiopian Highlands: A Case Study from the Lalibela Region"

by

Brian Clark

This thesis describes two field seasons of research around the historic church of Gännäta Maryam in the western highlands of Ethiopia, and the subsequent analysis of the landscape and archaeological remains recovered there. Gännäta Maryam Church was an important royal church from the 13th century onward. Though the archaeological landscape around the church likely possessed a wealth of information on the role of royal churches in medieval Ethiopian society, natural and anthropogenic landscape formation processes have greatly disturbed the archaeological integrity of the region, leaving few archaeological contexts intact. This thesis examines the Gännäta Maryam study area as a palimpsest landscape where centuries of human activity and landscape evolution have successively and cumulatively left their signatures on the terrain. Using principals and methods from behavioral archaeology and geoarchaeology, I analyze and describe the past and ongoing human occupation and landscape formation processes at Gännäta Maryam in order to understand how the archaeological record came to its present state. In doing so, I argue we can trace the processes of archaeological site formation, thereby achieving a more accurate interpretation of the archaeological landscape in spite of its poor preservation. In broader terms, this project provides a case study on archaeological site formation processes in the Ethiopian highlands whose lessons and methods can improve future research and interpretation in disturbed sites and archaeological landscapes across the highlands.

## **Acknowledgement**

I would like to kindly thank all those people without whom this dissertation could not be possible. To Susan McIntosh and Jeffrey Fleisher, who educated, encouraged and supported me throughout my time in graduate school, and without whom this dissertation would not have come about. To my parents Kevin and Cathy Clark, whose tireless support and belief in me is what made my success in graduate school possible. Additional thanks to Cathy Clark, who deserves an honorary degree in Anthropology for her hours spent proofreading many of the things I have written throughout graduate school. To John Knouse, who was always there when I needed to vent my frustrations, and who shared in my excitement over every success. Thank you to the National Science Foundation and its members, who believed and trusted me enough to sponsor my fieldwork. Thank you also to Tania and Chris Tribe, Niall Finneran, and Catherine D'Andrea, who introduced me to the world of Ethiopian archaeology and made my research possible. Thank you to Jean Aroom and Kim Ricker, who patiently continued my invaluable and fun education in GIS software. Many warm thanks and equal congratulations to my fellow colleagues and graduates in Rice Anthropology, whose support and friendship kept me going: A. Alazeh, A. Babatunde Babalola, C. Bendixen, T. Chryssikos, M. Cisse, L. Dib, T. Durbin, E. Vaughn Empey, M. Griffiths, R. Mantel, S. Pereira, E. Ranova, M. Vidart, and D. White. Many thanks also to my friends outside Rice, whose friendship and encouragement made my time here a joy and helped me remain sane through this tough time: O. Ahmed, K. Allen, R. Baker IV, S. Hoffman, A. and A. Howard, A. Jainchill, R. Martin, C. McBride, J. McKeel, C. Morgan, A. Offner, D. Pagnano (RIP buddy), N. Pizzolatto, C. Rosenthal, J. Rung, J. Townsend, S. B. Wilson. Special thanks to my friends who went beyond the duties of regular friendship during my graduate career: N. Naficey, who fed me and provided much needed emotional

support as I began graduate school; to C. Combs and M. Rosenthal, without whose help my ceramic analysis would never have gotten off the ground; to L. Reed, without whom I would have been left to do all my illustrations by hand; and to A. Mengistu and H. Tesfaye, who are not only excellent colleagues, but vigilantly made sure I didn't do anything too foolish as a *faranji* wandering around Ethiopia. Thank you also Loretta and Marlese Pisegna, who opened their home to me and made me feel like family for many years. And a final thank you to all the wonderful people of Lalibela and Gännäta Maryam. Though I was a stranger, and certainly seemed strange, you did not hesitate to welcome me and treat me as a friend and family. I will remember all of you always.



# Table of Contents

<b>Acknowledgement</b> .....	<b>iii</b>
<b>Table of contents</b> .....	<b>v</b>
<b>List of figures</b> .....	<b>xi</b>
<b>List of tables</b> .....	<b>xvi</b>
<b>Chapter 1: Introduction to the thesis</b> .....	<b>1</b>
1.1. Introduction .....	1
1.2. Landscape archaeology at Gännäta Maryam .....	3
1.3. Fieldwork .....	6
1.4. The artifacts and their contexts .....	7
1.5. The analysis and interpretation .....	8
<b>Chapter 2: Background to Gännäta Maryam</b> .....	<b>10</b>
2.1. Introduction .....	10
2.2. Historical context .....	12
2.3. Previous research .....	18
2.4. Contemporary Gännäta Maryam: A general area description .....	20
2.5. Gännäta Maryam and its people .....	26
2.5.a. The population and settlement pattern .....	26
2.5.b. Occupations and agriculture .....	27
2.5.c. Agriculture and the agricultural year .....	29
2.6. Geology and geomorphology of the Gännäta Maryam region .....	32
2.7. Hydrology .....	36
2.8. Geomorphology and pedology .....	39
2.9. Climate and ecology .....	49
2.10. Built features .....	50
2.11. Local flora and agriculture .....	55

2.12. Fauna .....	57
<b>Chapter 3: Landscape formation processes and research at Gännäta Maryam .....</b>	<b>59</b>
3.1. Introduction .....	59
3.2. Defining landscape .....	60
3.3. Formation processes .....	62
3.4. Behavioral Archaeology .....	64
3.5. Geoarchaeology and geomorphology .....	66
3.6. Studying formative processes at Gännäta Maryam and interpreting the archaeological record there .....	71
<b>Chapter 4: Research methodology and fieldwork .....</b>	<b>77</b>
Part I: Research development and methods	
4.1. Introduction .....	77
4.2. Research phase I: Initial site visit and research proposal .....	78
4.3. Research phase II: Research design and implementation .....	79
4.4. Research phase III: Surface collections, excavations, and oral histories .....	85
4.4.a. Surface collections.....	86
4.4.b. Oral history, ethnoarchaeology and aerial photography .....	89
4.4.c. Excavations .....	92
Part II: Field results	
4.5. Introduction .....	94
4.6. Oral history and ethnography .....	94
4.6.a. Oral history and ethnography: landscape changes at Gännäta Maryam in the 20th and 21st centuries.....	94
4.6.b. Oral history and ethnography: Systemic and archaeological contexts; the reuse, discard, and recycling of artifacts .....	108
4.6.c. Oral history and ethnography: Agricultural practices, historical changes, and their effects on behavioral practices and the environment.....	111
4.7. Shovel testing .....	113
4.7.a. Shovel tests, Tabot Madera, Area A .....	115
4.7.b. Shovel test, Tarla Terrara, Area B.....	117
4.7.c. Shovel tests, Tabot Madera, Area C .....	118
4.7.d. Shovel tests, Valley Survey .....	119
4.7.e. Shovel tests, Alem Doret, Area D .....	120

4.7.f. Shovel tests, Alem Doret, Area E .....	121
4.8. Profiles .....	122
4.8.a. Wadi profile, Tabot Madera ("Unit 2") .....	123
4.8.b. Earthen terrace riser profile, Tabot Madera ("Unit 3") .....	125
4.9. Excavations .....	126
4.9.a. Unit 1: test unit at Alem Doret, Area D.....	128
4.9.b. Unit 4: Tarla Terrara Hill .....	130
4.9.c. Unit 5: Tarla Terrara Hill.....	135
4.9.d. Unit 6, Kiflie Mado .....	137
4.9.e. Unit 7, Kiflie Mado.....	139
4.9.f. Unit 8, Kiflie Mado .....	140
4.10. Cemetery excavations .....	143
4.11. Surface collections .....	147
4.11.a. The control study: Surface collection L, Alem Doret, Area D.....	152
4.11.b. Surface collections A and B, Tabot Madera, Area A .....	158
4.11.c. Surface collection D, Tabot Madera, Area A .....	163
4.11.d. Surface collection E, Tabot Madera, Area A .....	165
4.11.e. Surface collection F, Tabot Madera, Area A .....	167
4.11.f. Surface collection G, Tarla Terrara.....	168
4.11.g. Surface collection H, Alem Doret .....	171
4.11.h. Surface collection I, Tabot Madera, Area C.....	174
4.11.i. Surface collection J, Tabot Madera, Area A .....	176
4.11.j. Surface collection N, Agay Midir .....	179
4.11.k. Surface collection O, Kiflie Mado .....	182
4.12. Conclusion .....	185
<b>Chapter 5: Formation Processes at Gännäta Maryam .....</b>	<b>188</b>
5.1. Introduction.....	188
5.2. Introduction to geomorphic processes .....	190
5.3. Ethiopian highland formation processes .....	200
5.4. Human impacts on landscape degradation in Ethiopia.....	209
5.5. Formation processes at Gännäta Maryam.....	219

5.5.a. Steep slopes .....	220
5.5.b. The hilltops .....	224
5.5.c. Vertic slopes .....	227
5.5.d. The sloping margins of the alluvial plain .....	229
5.5.e. The alluvial plain .....	231
5.5.f. Pediments .....	234
5.6. Discussion of formation processes at Gännäta Maryam and their relevance to archaeological research there .....	235
5.7. Plowzone processes and surface archaeology.....	236
5.7.a. Topography and plow soils.....	237
5.7.b. Plowing, erosion, and artifact patterns in the shovel tests.....	245
<b>Chapter 6: Artifacts .....</b>	<b>250</b>
Part I: Ceramics	
6.1. Introduction.....	250
6.2. Contemporary ceramic use and ceramic alternatives in Gännäta Maryam.....	251
6.3. Contemporary ceramic production and similarities with the archaeological assemblage .....	256
6.4. The archaeological assemblage: Introduction.....	261
6.5. Previous research and caveats.....	263
6.6. Analytical approach .....	265
6.7. Recovery, sampling, and analysis procedures .....	267
6.8. Ceramic ware types.....	269
6.9. Manufacturing and paste.....	271
6.10. Vessel components and features .....	274
6.11. Plastic decoration .....	277
6.12. Vessel types and rims.....	281
6.13. Conclusion .....	288
Part II: Lithics	
6.14. Flaked stone tools .....	295
6.15. Miscellaneous lithic materials.....	298
Part III: Faunal remains	
6.16. Faunal remains .....	300

Part IV: Metals	
6.17. Metals.....	302
<b>Chapter 7: Conclusion.....</b>	<b>307</b>
7.1. Introduction.....	309
7.2. Research at Gännäta Maryam: landscape formation processes and site formation .....	310
7.3. Results of ethnographic research, aerial imagery, and other inquiries into local formation processes .....	312
7.4. Formation processes and fieldwork results.....	316
7.5. Conclusion: The chronological evolution of Gännäta Maryam.....	319
7.5.a. The 17th century .....	319
7.5.b. 1700s to c. 1974.....	324
7.5.c. 1974 to present.....	327
7.6. Discussion .....	330
<b>Bibliography .....</b>	<b>332</b>
<b>Appendix A: Shovel test results .....</b>	<b>362</b>
<b>Appendix B: Radiometric dating results .....</b>	<b>371</b>
<b>Appendix C: USLE calculations .....</b>	<b>378</b>
<b>Appendix D: Faunal inventory .....</b>	<b>380</b>
<b>Appendix E: Ceramics.....</b>	<b>382</b>
Part I: Research Definitions	
E.1. Recording methods and terminology .....	382
Part II: Rim Types and Other Vessel Components	
E.2. Introduction: Rims .....	389
E.3. Open rims .....	390
E.3.a. Open, rounded rims .....	390
E.3.b. Open, unrounded, high-angled rims.....	393
E.3.c. Open, unrounded, low-angled rims .....	397
E.3.d. Open, recurved rims .....	400
E.4. Flat and shallow rims .....	401
E.4.a. Shallow, upturned rims .....	401
E.4.b. Shallow rims .....	404

E.4.c. Flat rims.....	408
E.5. Vertical and sub-vertical rims .....	409
E.5.a. Vertical rims .....	410
E.5.b. Sub-vertical rims with inverted lips .....	415
E.6. Closed rims .....	416
E.7. Everted and restricted rims .....	419
E.7.a. Open, everted rims and lips.....	419
E.7.b. Restricted, vertical to everted rims .....	423
E.8. Miscellaneous rims and other vessel components .....	425
E.8.a. Closed, recurved rims or carinated vessels .....	425
E.8.b. Bulbous-lipped rims .....	426
E.8.c. Lids.....	428
E.8.d. Flat bases.....	429
<b>Appendix F: Ceramic petrography report .....</b>	<b>430</b>
<b>Appendix G: Metals inventory .....</b>	<b>456</b>

## List of Figures

2.1. Gännäta Maryam study area and other locations .....	11
2.2. Gännäta Maryam Church.....	14
2.3. Important locations in the study area .....	21
2.4. View of Tabot Madera, Tarla Terrara and Agay Midir .....	24
2.5. View of the lower terrace.....	24
2.6. The Western Highlands of Ethiopia and important locations .....	33
2.7. Topographic map of the study region .....	36
2.8. Hydrology of the study area.....	38
2.9. Vertisol clay .....	40
2.10. Soil in the study area.....	41
2.11. Surface soil map.....	42
2.12. Bedrock geology map .....	43
2.13. View of the lower terrace and upper slopes of Tabot Madera .....	46
2.14. Confluence of the gullies at Tabot Madera.....	47
2.15. <i>Tukul</i> house .....	54
2.16. <i>Nas</i> house .....	54
2.17. Modern house.....	55
4.1. Research area overview map .....	82
4.2. Lower terrace research areas.....	83
4.3. Upper terraces research areas.....	83
4.4. Wild vegetation at Gännäta Maryam Church .....	95
4.5. Wild vegetation at Yemrehanna Krestos Church.....	96
4.6. Historic vegetation regrowth.....	98
4.7. Historic vegetation regrowth.....	99
4.8. Historic meandering of the wadi.....	102

4.9. Recently built stone and earth bund.....	104
4.10. Growth of Gännäta Maryam Village .....	107
4.11. Lithics reused by children.....	111
4.12. Map of shovel tests .....	114
4.13. Slope erosion and bund recapture.....	117
4.14. Wadi profile excavation locations .....	124
4.15. Comparison of wadi profiles.....	125
4.16. Terrace riser profile.....	126
4.17. Lower terrace excavation locations .....	127
4.18. Upper terrace excavation locations.....	128
4.19. Alem Doret Unit 1 map.....	130
4.20. Tarla Terrara Units 4 and 5 map.....	131
4.21. Unit 4 photograph .....	132
4.22. Locus 4008/9 (pit feature) photograph .....	133
4.23. Loci 4008/9 and 4006 profiles .....	133
4.24. Unit 5 photograph .....	136
4.25. Unit 5 profile.....	136
4.26. Kiflie Mado excavation map.....	138
4.27. Unit 6 photographs.....	139
4.28. Unit 8 profile.....	142
4.29. Traditional cemetery .....	144
4.30. Eroding burials at Gännäta Maryam Church .....	144
4.31. Gännäta Maryam Church cemetery .....	145
4.32. Gännäta Maryam Church burial profile.....	146
4.33. Lower terrace shovel test map .....	149
4.34. Tabot Madera surface collection photograph .....	150
4.35. Upper terrace surface collection map .....	151
4.36. Surface collection L photograph.....	152
4.37. Surface collection L: distribution of large ceramics .....	156
4.38. Surface collection L: distribution of small ceramics .....	157
4.39. Surface collection L: distribution of lithic artifacts .....	158



4.40. Surface collections A and B, Tabot Madera, Area A: distribution of large ceramics .....	161
4.41. Surface collections A and B, Tabot Madera, Area A: distribution of small ceramics .....	162
4.42. Surface collections A and B, Tabot Madera, Area A: distribution of all ceramics .....	163
4.43. Surface collection D, Tabot Madera, Area A: distribution of all ceramics .....	164
4.44. Surface collection E, Tabot Madera, Area A: distribution of large ceramics .....	166
4.45. Surface collection E, Tabot Madera, Area A: distribution of small ceramics .....	167
4.46. Surface collection F, Tabot Madera, Area A: distribution of all ceramics .....	168
4.47. Surface collection G, Tarla Ferrara: distribution of large ceramics .....	170
4.48. Surface collection G, Tarla Ferrara: distribution of small ceramics .....	171
4.49. Surface collection H, Alem Doret: distribution of large ceramics .....	173
4.50. Surface collection H, Alem Doret: distribution of small ceramics .....	174
4.51. Surface collection I, Tabot Madera, Area C: distribution of analyzed ceramics ...	175
4.52. Surface collection I, Tabot Madera, Area C: distribution of small ceramics .....	176
4.53. Surface collection J, Tabot Madera, Area A: distribution of large ceramics .....	178
4.54. Surface collection J, Tabot Madera, Area A: distribution of small ceramics .....	179
4.55. Surface collection N, Agay Midir: distribution of large ceramics .....	181
4.56. Surface collection N, Agay Midir: distribution of small ceramics .....	182
4.57. Surface collection O photograph .....	183
4.58. Surface collection O, Kiflie Mado: distribution of all ceramics .....	185
5.1. Fluvial erosion processes .....	191
5.2. Stratified wadi profile photograph .....	200
5.3. Severity of soil erosion in Ethiopia .....	205
5.4. Sediment budget of May Zegzeg .....	209
5.5. Photograph of the saddle at Tarla Ferrara .....	217
5.6. Photograph of the saddle at Tarla Ferrara .....	218
5.7. Comparison of east and west wadi profiles .....	233
6.1. Modern pottery at Gännäta Maryam .....	253
6.2. Modern pottery at Gännäta Maryam .....	254
6.3. Modern pottery from the Lalibela region .....	255

6.4. Modern pottery from the Lalibela region.....	256
6.5. Grinding stone used in pottery production.....	257
6.6. Pottery firing pit .....	261
6.7. Frequency of small and large ceramic classes .....	268
6.8. Relative frequency of sand and <i>geha</i> tempers .....	272
6.9. Relative frequency of temper volumes .....	273
6.10. Mortise and tenon pottery sherds.....	275
6.11. Cut and coil built carinated body sherds.....	276
6.12. Aksumite and medieval carinated profiles.....	276
6.13. Modern carinated ceramic.....	277
6.14. Sgraffito decoration motifs .....	280
6.15. Punctured ceramic sherds .....	282
6.16. Open rim profiles .....	283
6.17. Vertical and flat rim profiles .....	284
6.18. Closed and everted rim profiles .....	285
6.19. Pecked stone ball.....	299
6.20. Iron nail .....	303
6.21. Iron coil.....	304
6.22. Iron artifact .....	304
6.23. Iron knife tip .....	305
6.24. Iron smithing slag .....	307
6.25. Tuyère fragment.....	308
E.1. Particle frequency chart.....	386
E.2. Type 1 open, rounded rims .....	392
E.3. Type 2 open, rounded rims .....	393
E.4. Type 1 open, unrounded, high-angled rims.....	395
E.5. Type 2 open, unrounded, high-angled rims.....	396
E.6. Type 3 open, unrounded, high-angled rims.....	397
E.7. Open, unrounded, low-angled rims .....	309
E.8. Open, unrounded, low-angled rims as lids .....	400
E.9. Open, recurved rims .....	401

E.10. Types 1 and 2 shallow, upturned rims.....	403
E.11. Type 1 shallow rims .....	406
E.12. Type 2 shallow rims .....	407
E.13. Flat rims.....	409
E.14. Type 1 vertical rims.....	412
E.15. Type 2 vertical rims.....	413
E.16. Type 3 vertical rims.....	414
E.17. Type 4 vertical rims.....	414
E.18. Type 5 vertical rims.....	415
E.19. Sub-vertical rims with inverted lips .....	416
E.20. Closed rims .....	418
E.21. Type 1 open, everted rims and lips.....	422
E.22. Type 2 open, everted rims and lips.....	422
E.23. Type 3 open, everted rims and lips.....	423
E.24. Type 4 open, everted rims and lips.....	423
E.25. Restricted, vertical to everted rims .....	424
E.26. Closed, recurved rims or carinated vessels .....	426
E.27. Type 1 bulbous-lipped rims .....	427
E.28. Type 2 bulbous-lipped rims .....	428
E.29. Lids .....	429
E.30. Flattened bases .....	429

## **List of Tables**

4.1. Rubric of potential settlement types and identifying features .....	81
4.2. Summary of Tabot Madera, Area A shovel tests .....	116
4.3. Summary of Tabot Madera, Area C shovel tests .....	119
4.4. Summary of Alem Doret, Area D shovel tests .....	121
4.5. Unit 1: Alem Doret, Area D test unit summary table .....	129
4.6. Unit 8: Kiflie Mado test unit summary table .....	141
5.1. Hurni's USLE factors calibrated to Ethiopia.....	202
5.2. Average soil depths in Ethiopia .....	205
5.3. Rate of geomorphic processes at May Zegzeg .....	208
5.4. Erosion factors in the study area .....	211
5.5. Surface collections and their artifact patterns relative to topography.....	246
6.1. Distribution of Fine Red Ware.....	271
6.2. Frequency and location of burnishing and slipping .....	278
6.3. Frequency of slip colors.....	278
6.4. Distribution of sgraffito decoration .....	279
6.5. Distribution of rim categories .....	286
6.6. Distribution of lithics .....	296
A.1. GMTM: A; ST: North 1 .....	362
A.2. GMTM: A; ST: North 2 .....	362
A.3. GMTM: A; ST: North 3 .....	362
A.4. GMTM: A; ST: North 4 .....	363
A.5. GMTM: A; ST: North 5 .....	363
A.6. GMTM: A; ST: West 1 .....	363
A.7. GMTM: A; ST: West 2 .....	363
A.8. GMTM: A; ST: West 3 .....	363

A.9. GMTM: A; ST: West 4 .....	364
A.10. GMTM: A; ST: West 5 .....	364
A.11. GMTT: B; ST: 1 - middle of hilltop .....	364
A.12. GMTM: C; ST: East 1 .....	365
A.13. GMTM: C; ST: East 2 .....	365
A.14. GMTM: C; ST: East 3 .....	365
A.15. GMTM: C; ST: Southwest 1 .....	365
A.16. GMTM: C; ST: Southwest 2 .....	366
A.17. GMTM: C; ST: Southwest 3 .....	366
A.18. GMTM: C; ST: Southwest 4 .....	366
A.19. GMTM: C; ST: Southwest 5 .....	366
A.20. GMTM Valley Transect; ST 1 .....	367
A.21. GMTM Valley Transect; ST 2 .....	367
A.22. GMTM Valley Transect; ST 3 .....	367
A.23. GMTM Valley Transect; ST 4 .....	367
A.24. GMTM Valley Transect; ST 5 .....	367
A.25. GMTM Valley Transect; ST 6 .....	368
A.26. GMTM Valley Transect; ST 7 .....	368
A.27. GMAD: D; ST: 1 .....	368
A.28. GMAD: D; ST: 2 .....	368
A.29. GMAD: D; ST: 3 .....	369
A.30. GMAD: D; ST: 4 .....	369
A.31. GMAD: D; ST: 5 .....	369
A.32. GMAD: E; North-Northwest 1 .....	369
A.33. GMAD: E; North-Northwest 2 .....	369
A.34. GMAD: E; South-Southeast 1 .....	370
A.35. GMAD: E; South-Southeast 2 .....	370
A.36. GMAD: E; South-Southeast 3 .....	370
A.37. GMAD: E; South-Southeast 4 .....	370
C.1. Hurni's USLE factors calibrated to Ethiopia .....	379
D.1. Descriptions of faunal remains from excavations .....	380

E.1. Ceramic paste color values .....	384
E.2. Ceramic non-plastic inclusions.....	385
E.3. Ceramic size range categories .....	385
E.4. Ceramic decorative techniques .....	387
E.5. Ceramic vessel location terms .....	387
E.6. Ceramic slip color values .....	388
F.1. Quinn's petrographic group 1 .....	431
F.2. Quinn's petrographic group 3 .....	431
F.3. Quinn's petrographic group 4 .....	432
F.4. Quinn's petrographic group 5 .....	432
F.5. Quinn's petrographic group 6 .....	432
F.6. Quinn's petrographic group 7 .....	432
F.7. Quinn's petrographic group 8 .....	432
F.8. Quinn's petrographic group 9 .....	433
G.1. Inventory of metal artifacts .....	456
G.2. Inventory of metal slag from surface collection O .....	457

## **Chapter 1**

### **Introduction to the thesis**

#### **1.1. Introduction**

The modern nation of Ethiopia is well known for its spectacular monumental archaeological and historical sites like Aksum and Gondar. However, the draw to archaeologists of such sites has created an imbalance in the attention archaeologists have paid to Ethiopia's large and diverse archaeological heritage. Archaeologists frequently focus on these highly-visible, often durable or monumental sites like Aksum or Lalibela, while giving considerably less attention to ephemeral and non-monumental sites. Phillipson (2004) has also argued that a false division has occurred in the treatment and narrative of Ethiopian history where second millennium AD subject matter is divorced from its Aksumite Period heritage. The latter, he claims, has been perceived and is in practice largely the domain of historians, while the former, of archaeologists.

The research interests of this project, however, have broken away from the trends in previous research in numerous ways. The temporal focus is ostensibly on Ethiopia's medieval heritage rather than its Aksumite Period history. Precisely what would be found during fieldwork was uncertain, though there was good evidence for a royal medieval occupation which would have been built of ephemeral materials. The research area also lies on the geological terraces of the highland mountains, where little archaeological research has been conducted compared to broader, more open environments like the rolling plains, hills, and valleys of Tigray. Meanwhile, rather than focusing on a single "site" or collection of discrete "sites," this project emphasizes the

landscape and the entirety of its archaeological contents rather than presuming a single, contiguous occupational area.

Research for this thesis was conducted on the landscapes surrounding the historic rock-hewn church of Gännäta Maryam, about 11 km from the UNESCO World Heritage Site of Lalibela in the western highland mountains of Ethiopia. Gännäta Maryam is nestled into the geological scarps and narrow terraces that characterize the heavily dissected volcanic shields that give the Ethiopian highlands their most dramatic topography. As opposed to Ethiopia's better-known archaeological sites and landscapes, occupations at Gännäta Maryam appear to have left few large or impressive durable remains, despite the location's historical significance. What has remained has been shaped and modified by centuries of intense human occupation, a bimodal climatic regime, and the extreme topography. Together, these forces contribute to a dynamic landscape that continues to change as the different constituent variables interact, influencing both archaeological site formation and its gradual evolution. In the absence of durable archaeological contexts, I concluded that archaeological research at Gännäta Maryam must take into account the formation processes that have affected archaeological preservation in order to interpret the landscape's human history and make sense of its archaeological vestiges.

In many ways, Gännäta Maryam is typical of the highland region. The millennia of erosion that define the highland geomorphology have produced similar terrains across the western highlands. These landscapes are characterized by differently sized geological terraces, rocky terrain, and generally thin soils under intense agricultural pressure. The church of Gännäta Maryam, like the country's many prominent historic churches, is situated in one such setting. The church dates back many centuries, likely hosted a royally-sponsored religious community, and possibly other specialized settlements such as a royal camp. Both site types and many others of this period would likely have been built of impermanent materials like field stone houses and cloth or leather tents. The church and its surroundings then are of great archaeological and historical interest and share many features with similar areas of archaeological and historical importance, though archaeological remains at all such sites are likely to be ephemeral. It stands to reason then that lessons learned from fieldwork at Gännäta Maryam are applicable to



archaeological research elsewhere. Such lessons are invaluable because the dynamism of the terrain can be deceptive when compared to the experiences working at sites elsewhere, such as the monumental Aksumite and Pre-Aksumite sites in the north, situated in large plains and valleys. While the poor preservation of archaeological contexts at Gännäta Maryam may prevent a detailed reconstruction of local history and occupation based on the archaeological remains alone - at least until further baseline data for the region can be recovered - this study ought to serve as a primer for such future research. Thereby, future work may more productively "read" the archaeological landscape in *terra nova*, not only identifying and interpreting areas of high or low archaeological potential, but also seeing how continued human activity has since left its imprint on the archaeological landscape.

This thesis then is not only focused on the archaeological remains at Gännäta Maryam, but the landscape formation processes involved in the formation and transformation of the archaeological landscape. Only by understanding these processes can we come as near as possible to a satisfactory interpretation of the archaeological remains there, and by extension, can we do likewise in similar settings, using research methods suited to the conditions one will likely encounter. Interpretations of greatly transformed archaeological landscapes which may be the best preserved sites of ephemeral occupations we can hope to recover may be stymied if we cannot understand the processes they have undergone so that we may track back as near as possible their original position and the kinds of data lost. Meanwhile, appropriate reconnaissance and research methods are unlikely to be those that have worked so well in northern Ethiopia's better-known Aksumite and earlier heritage sites. Failure to account for the formation processes involved in landscape and archaeological site formation will likely lead to wasted efforts, expending time and resources on archaeologically unpromising areas.

## **1.2. Landscape archaeology at Gännäta Maryam**

As I argue in chapter 3, the landscape of Gännäta Maryam and similar settings is best conceived of as a palimpsest in the sense expressed by Crawford (1953) and others

(e.g. Bailey 2007). The highland landscape is a dynamic, constantly evolving system where human activities and natural processes progressively shape and reshape the terrain and its features. Each episode of human activity thus leaves its own traces on the landscape as archaeological deposits and anthropogenic features, while successive events continue to reshape the landscape in the creation of their own archaeological record. Over time, the record of human activities may appear muddled and confused with layers of occupation and activity collapsed spatially and chronologically. By studying dialectic relationships and ongoing processes of and between people and the environment, we can better reconstruct the transformations archaeological materials and contexts have undergone. Ideally, we can then achieve a better understanding of their original depositional context and kinds of information lost in the transition to the present.

The only way to understand these processes, then, is to examine both the human and the natural factors that constitute them independently and as an integrated system. Schiffer's (1976, 1995) theory and methods of "behavioral archaeology" and concern for formation processes (1987) provide ready and tested recommendations on how to go about this interpretation. On the one hand, all landscape formation processes are undergirded by natural formation processes. Geoarchaeology and geomorphological analysis address this aspect of the project. Fortuitously, the rapidly eroding landscape of Ethiopia, combined with episodes of food insecurity over the past few decades has spurred much research concerned with agricultural and environmental sustainability, closely examining and quantifying the geomorphological processes involved in shaping the Ethiopian highlands. This has additionally included the human impact on environmental change. With this extant body of research, reviewed in chapter 5, it is easy to combine and compare personal environmental research in the study area with baseline data on the broader geomorphology of the highlands, turning the research intended for other purposes to the needs of an archaeological study.

Hans Hurni (1978, 1983, 1985), for example, conducted extensive work measuring erosion and soil loss in the Ethiopian highlands, adapting variables of the Universal Soil Loss Equation (Wischmeier and Smith 1978) to Ethiopia. While we now know this equation tends to underestimate soil loss (see chapter 5), it nonetheless provides a good, conservative estimate that archaeologists may readily apply.

Meanwhile, other scholars have examined things like the effects of road construction (Ogbaghebiel and Brancaccio 1993; Nyssen et al. 2002), trampling by cattle (Mwendera and Saleem 1997), and soil displacement by plowing (Nyssen et al. 2000).

Geoarchaeologists and other scholars have likewise already assessed changing historical and archaeological landscapes in Ethiopia using geomorphological data and analysis (e.g. Butzer 1981; Bard 1997; Berakhi et al. 1998; French 2007), though to my knowledge no scholars have yet used such research to extensively reconstruct the formation and loss of archaeological landscapes and data. I was also able to conduct basic geomorphological mapping and research of my own using pedestrian surveys and basic archaeological methods like shovel tests and topographic surveying. By comparing the results of previous research to relevant variables and conditions in my research area, discussed in chapter 5, I argue we can better understand the nature and extent of landscape formation processes in different particular settings, and their likely effects on archaeological material over time.

The other half of Schiffer's "behavioral archaeology" is, of course, the human behavioral component. For this, there was also some available data, mostly related to agricultural and land-management practices. Chapters 3 and 5 cover some of the different ways scholars have documented or studied landscape changes induced by human behaviors in ways that are applicable to research in my study area. Many researchers, for example, have examined landscape changes over time using time lapsed photographs or aerial images (e.g. Crummey 1998; Kebrom and Hedlund 2000; Tegene 2002, and others, see chapter 4), which I was also able to test. Some scholars like Dejene (1990), provide invaluable historic context and ethnographic research on changing landscape and human land-use patterns. I have supplemented some of this data with direct research of my own, conducting ethnographic interviews and observations, for example.

Given that such methods have proven useful here and an extant body of related literature already exists for Ethiopia, they will undoubtedly remain fruitful and readily accessible means of conducting similar research in other research sites in Ethiopia in the future. Through these methods I learned much about land use patterns, their changes with the changing circumstances of life in the highlands, and peoples' knowledge of and

interactions with their material and archaeological cultures. Much of this is discussed in chapters 2 and 4, outlining the broader landscape of the study area and humans' occupation and activities conducted within it over time.

Finally, I also conducted some experimental archaeology. Through local interviews, I was able to gather data on the occupation and abandonment of a small, ephemeral home, the traces of which are still visible on the landscape. Knowing the history of the site from its construction to the present, I then surveyed it, conducted a surface collection, and excavated shovel tests (chapter 4). This provided a test-case for the formation and transformation of a known archaeological site due to common processes such as plowing for comparison with other archaeological finds. I also worked closely with the potters of Gännäta Maryam to learn about ceramic production techniques and had sample pottery-types made (chapter 6). This work was useful for making better sense of the very fragmentary pottery assemblage, most of it from plowzone contexts, in a region where we still lack a ceramic typology and chronology.

### **1.3. Fieldwork**

Because the goals of this project were not only to assess landscape and archaeological site formation processes in the highlands, but also to interpret the ephemeral archaeological sites that have produced the poorly-preserved remains at Gännäta Maryam, conventional archaeological reconnaissance and research was also a large part of this project (chapter 4). As mentioned above, however, archaeological methods frequently addressed both archaeological and geomorphological concerns. The areas targeted for survey and excavation were three geological terraces east of the modern village. The largest terrace, on the same level as the village, is an expansive and geomorphologically diverse area. Its key features are a small alluvial plain bounded by hills and the ascending terrace scarp, dissected by gullies. The other two terraces are situated above this lower one and are considerably narrower with more homogenous terrain. One terrace possessed voluminous amounts of slag, though much of the area has been disturbed by recent erosion remediation efforts.

The project began with a conventional surface survey and mapping of surface artifact scatters. However, soils and notes on the terrain were also made and the study area was divided conceptually into zones based on shared topographic and geomorphological features (e.g. "hills," "slopes," and the "alluvial plain"), both discussed as background in chapter 2. Following surveying, we began systematic and unsystematic shovel tests across the lower terrace. At first, these covered areas of surface artifacts in search of subsurface archaeological contexts. Later shovel tests were placed in areas without surface artifacts in order to map the region's stratigraphy and possibly identify archaeological contexts sealed beneath sterile strata. In the analysis, these shovel tests helped to illustrate the relationships between topography, soils, and artifact preservation. I then cut profiles into the wadi and a terraced soil bund, though the utility of both was questioned after further consideration of the settings chosen. Using shovel tests and surface surveying as a preliminary indicator of areas of possible archaeological interest, I then designated a number of areas for small-scale exploratory excavations. In most instances, such efforts were rewarded with the few instances of preserved sub-surface archaeological contexts. Like the shovel tests, they also helped to identify patterns in the geomorphology of the region where archaeological contexts appear to preserve well. Finally, in light of the dearth of intact archaeological contexts, we conducted extensive surface collections in areas where surface artifacts were present. Initially, I began surface collecting in order to gather a larger sample of regional ceramics and other artifacts to supplement the small volume recovered from archaeological contexts. However, combining such surface survey results with topographic data and local landscape features, I was able to model artifact displacement by forces such as plowing, erosion, and graviturbation.

#### **1.4. The artifacts and their contexts**

Chapter 6 delves into the artifact analysis and the conclusions drawn from them. Following fieldwork, I ordered radiocarbon dates to help locate features and associated artifacts in time. Preliminary analysis of the faunal remains was conducted by a

specialist, though I concluded afterward that without better preserved contexts, the results are of little interpretive value. Artifacts like lithics and metals were recovered in very small numbers, primarily from plowzone contexts. Their dearth, I argue, is likely due to anthropogenic processes such as recycling of material and the effects of plowing on artifact distributions, which I discuss in chapter 5, rather than indicating their scarcity in the past. Ceramics were the only artifact class recovered in great numbers, though the overall impression of the assemblage is that it is comprised mostly of quotidian objects with little discernible variation in manufacture, form, or decoration over the span of time that they represent. There were a few minor exceptions, though these I conclude can be attributed to fairly recent historical events and may not be universally relevant to research elsewhere in Ethiopia.

### **1.5. The analysis and interpretation**

The second half of chapter 5 brings the archaeological, historical, and geomorphological results discussed in the previous chapters together for a discussion of how the relevant factors have contributed to archaeological site trans/formation. Combinations of land use practices, soils, and topography proved to be well-suited means for dividing the landscape into units and to examine the influences of different processes under these discrete geomorphological units. I discuss how archaeological deposits in these areas have responded to and changed over time due to the processes they have undergone. This leads into discussions of the biases in preservation or artifact recovery in these areas and the potential for the good preservation of archaeological materials in these and similar settings.

After a summary of the data, the second half of chapter 7 concludes the thesis with a historical narrative reconstructing the occupational history of the study area and its changing landscape, coming to a final conclusion on the origins of the archaeological materials recovered. By combining the artifact analysis, radiocarbon dates, and the geomorphological patterns discussed in the latter half of chapter 5, I present a reasonable assessment of the study area's history and the relevance of its archaeology and formation

processes for reconstructing that history. The conclusions, however, are perhaps unsettling as they suggest that few if any archaeological remains from ephemeral settlements or activities may survive beyond a few centuries. It bears keeping in mind, however, that the study area is small, and it remains unknown what kinds of settlements or activities may have taken place within the study area beyond the time represented by the extant archaeological remains and contexts. The conclusion is followed then by a call for further research into the study of formation processes and their effects on archaeological site preservation, and recommendations for future research.

## **Chapter 2**

### **Background to Gännäta Maryam**

#### **2.1. Introduction**

The following provides a basic background on Gännäta Maryam and its surrounding region (Figure 2.1). The information is meant to situate Gännäta Maryam in its historical and natural context. First, I will outline the historical context of Gännäta Maryam, including the significance of the church, the factors that encouraged research there, and some historical changes like the land reformations of the Derg. The latter affected land use practices and in turn, the natural processes affecting archaeological preservation.

Following this historical context I will situate the landscape in its environmental context. As much of this thesis is concerned ultimately with how natural processes, often conditioned by behavioral processes, have affected archaeological contexts, it is essential to understand the wider physical setting. Furthermore, this information on general setting demonstrates the value of this research for approaching archaeological contexts elsewhere in Ethiopia. Because Gännäta Maryam represents only a very small part of a much wider region sharing very similar geophysical and historical attributes, it stands to reason that conditions and processes affecting archaeological heritage at Gännäta Maryam are likely elements at play elsewhere in the highlands.



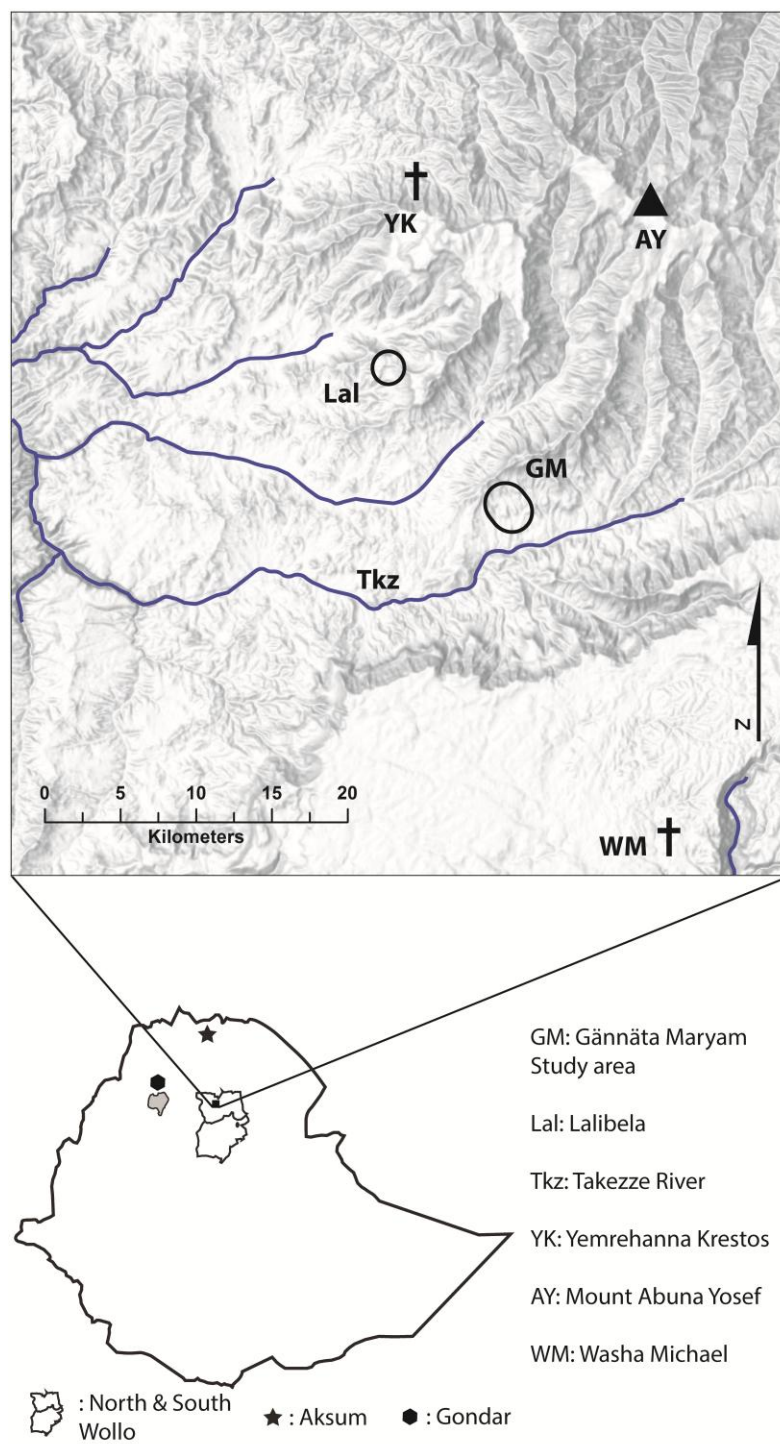


Figure 2.1. Gännäta Maryam study area and other locations.

## 2.2. Historical context

Gännäta Maryam, residing just south of the headwaters of the Takezze River, was once in the historic territory of Lasta, home of the Agaw ethnic group, a Cushitic-speaking ethnic group surrounded by majority Semitic ethnic groups such as the Amhara to the south and Tigrinya to the north (Tamrat 2009[1972]: 25-29, 53). Though the precise boundaries of the Agaw territory are not known, it certainly contained the area around Lalibela, which was later the seat of the Agaw Zagwe Dynasty. The southern boundary of the Agaw region was probably the Takezze River headwater or the massif beyond it, which divides the region from the historic kingdom of Shewa, populated by Amharic peoples (local interviews; see also Tamrat 2009[1972]: 65). Textual accounts associate the Lasta region with the Aksumite state through the first millennium AD (see discussion by Tamrat 2009[1972]: 24-34). Regional surveying in 2009 did indeed find artifacts and architectural elements strongly rooted in the Aksumite tradition besides the obvious affinities seen in the Lalibela churches (Finneran 2011; Tribe 2014).

Aksum was the seat of a large, multi-ethnic state for much of the early and mid first millennium AD. Christianity was adopted as the official state religion in the fourth century, and the monastic tradition was introduced by the fifth century. Due to a number of factors, Aksumite power declined and the city was abandoned as the political capital of the state during the latter part of the first millennium (see Selassie 1972 and Phillipson 2012 for definitive histories of Aksum and the period). Following Aksum's decline, the historical events of the Ethiopian highlands are murky until the emergence of the Zagwe dynasty by the 12th century. During the Zagwe Dynasty, a massive church-building campaign was undertaken in the region of the then-capital, Roha (Finneran 2009). The precise location of Roha is yet to be identified, though the posthumously named town of Lalibela with its 11 rock-hewn churches remains a testament to the artistic and architectural achievements of the Agaw through this period (Finneran 2009). It is possible that the church of Gännäta Maryam was also built during this period, though all proposed dates for the church's construction are currently speculative (for recent attempts at chronology and dating, see Phillipson 2009 and Fauvelle-Aymar et al. 2010).

Though the Zagwe kings undoubtedly achieved greatness within their own homeland, their legitimacy was contentious among the other ethnic groups, particularly those of Semitic origins. The Shewan prince Yekuno Amlak managed to leverage this displeasure with the Zagwe Dynasty to his advantage. According to the chronicle of the priest Iyasus Mo'a, Yekuno Amlak convinced his contemporaries that he, and not the Zagwe scions, was the rightful descendent of the Aksumite kings (Kur 1965: 19-26). With the support of the clergy and other factions, Yekuno Amlak overthrew the Zagwe Dynasty in 1270 and installed himself as king of the "restored" Solomonic Dynasty.

Following his conquest of Lasta and ascension to the throne, it would have been imperative for Yekuno Amlak to consolidate his power in the region. It is the hypothesis of the Solomonic - Zagwe Encounters Project (see also Derat 2009) that as one component of his legitimization and consolidation of local authority, he built or appropriated religious monuments and institutions around the Zagwe heartland, surrounding Lalibela/Roha, for his own glorification. Among these was the church of Gännäta Maryam (Figure 2.2). Again, whether he built or merely appropriated the church is uncertain, though within a short time after his ascension, the church was frescoed with a dedicatory panel featuring the King and his appointees to manage the church (see Lepage 1975: 64; Heldman and Haile 1987: 4; Balicka-Witakowska 2007; Phillipson 2009: 116-8, 188). Recent investigations of the church treasury identified artifacts associated with the king. Of particular note is a large Mamluk Period Egyptian platter supposedly gifted to the king from Egypt and inscribed on the back with a dedicatory inscription to Yekuno Amlak and a list of territories under his control. Later investigation tentatively identified the platter as dating to the early 14th century, just after Yekuno Amlak's death and the succession of his son (Tribe 2013 pers. comm.). Also housed in the church treasury is one of two known royal chronicles of his reign, currently in translation, though the two known manuscripts are suspected to date to relatively recent historical times (Lepage 1976: 328; Tribe 2013 pers. comm.).



Figure 2.2. Gännäta Maryam under recent protective roofing. The scarp to the right levels off at the vegetation line and becomes Agay Midir, with another ascending terrace scarp behind it.

Whether Yekuno Amlak personally ordered the construction of Gännäta Maryam church or not is less important than the effect of its use for his own legitimization. The church is hewn out of rock like the Lalibela churches, and in appearance is mimetic of Medhane Alem church in Lalibela. The latter, in turn, is believed to have been an imitation of the original Maryam Tsion church in Aksum, the first known basilica in Ethiopia (Buxton 1947; Heldman 1992). Maryam Tsion has long been the spiritual center of Ethiopian Christianity, while Aksum was an important pilgrimage and enthrone site for Medieval monarchs (Tamrat 2009[1972]: 248-249), reinforcing their supposed direct descent from the Aksumite kings (Heldman, 1992: 232). The tie between Yekuno Amlak and Gännäta Maryam church in the heartland of the Agaw Zagwe homeland then was perhaps a means to appeal to this heritage while simultaneously appropriating or outshining an achievement and symbol of Zagwe power and authority.

The donor portrait in the church includes an inscription describing the church's first appointed priest (Lepage 1975: 64; Heldman and Haile 1987). This and the presence of the Mamluk platter suggest the church was very likely a royal church receiving royal patronage, as has been argued by Bartnicki and Mantel-Niecko (1969/70: 6). According to oral history, the church was also the seat of a monastic community, which for much of Ethiopian history were often well-organized, powerful and influential institutions (e.g. Crummey 2000; Derat 2003) (for brevity, Gännäta Maryam will be referred to as a church, though its monastic component is implied). Throughout the Solomonic Period, such royal churches and monasteries played critically important roles in Ethiopian life as an extension of royal power and authority (Finneran and Tribe 2004: 71; Derat 2003; Derat and Pennec 2007), and often as important political, social, and economic centers in their own right (Bartnicki and Mantel-Niecko 1969/70; Finneran 2003; Derat 2003). According to the current clergy, Gännäta Maryam held *gult* rights over the surrounding landscape until the abolishment of the system by the Derg in 1975. *Gult* rights were granted by the emperor to lords and religious institutions (see Tamrat 2009[1972]: 100-103 and Crummey 2000 for detailed discussions of *gult*). Such rights were similar to the European feudal rights of the nobility (Crummey 1980), granting appointees rights to extract quotas of labor and resources from the land's residents, and often to manage travel, taxation, and markets within the territory. Such churches might also serve as storehouses for the royal treasury, of which the platter may be an example, and perhaps as an infrastructural node supplying the frequently itinerant royal court. As a result, such churches became wealthy and influential institutions in their regions, while cyclically reinforcing the prestige and authority of the sponsoring monarchs.

Sometime following the Solomonic conquest, the region experienced a series of changes in relation to its broader surroundings. At some point, the region assimilated into the larger Amharic ethnic identity, such that Amharic eventually replaced Agaw as the common language (see below). During the 17th century, Gondar became the empire's permanent, fixed capital, while imperial territory slowly contracted, along with central control of the provinces (Marcus 2002). The Lasta region like many others during this period and perhaps even prior, exercised greater autonomy under their own secular lords and the power and prestige of royal churches presumably shifted with the whims of now

more influential local kings and nobles (see discussions by Abir 1980: 181, Haile 1988, Derat 2009; Bosc-Tiesse and Derat 2011). Throughout the 19th century, imperial control and centralization of power was again established over the empire as the modern nation state emerged, though there is currently no documented evidence that Gännäta Maryam possessed any notable political and social significance beyond its immediate surroundings by this period.

During the 20th century, the classification of the former Lasta territory changed periodically throughout the imperial, socialist, and contemporary periods, though it remained associated with the wider majority-Amharic regional identity. Under the Derg, Lasta was made a *woreda*, or local administrative zone, incorporated into the wider Wollo (alternatively, Wello) Administrative Zone. Following the Derg, Wollo was broken up into North Wollo and South Wollo Administrative Zones. Lasta *woreda* became part of North Wollo, which itself is part of the modern Amhara National Regional State, one of the nine ethnic divisional states of Ethiopia. As of the 2007 census (General Statistical Agency, Ministry of Finance and Economic Development 2007), 97.47% of the Amhara State population claim Amharic as their "mother tongue." Within North Wollo, less than 1% of the population speaks an Agaw language today.

Whatever power Gännäta Maryam exercised over its landscape during the later part of the 20th century came to an abrupt end with the land reforms initiated under the Derg military junta following the 1974 revolution. From 1975 through the mid 1980s, the Derg instituted a number of policies and political reforms aimed at socializing land and resources, the two most important being the *Public Ownership of Rural Lands Proclamation No. 31/1975* and the *Peasant Associations Consolidation Proclamation No. 223/1982* (see Shinn and Ofcansky 2013: 261-2 and 409 for a general summary). The former along with other policies dismantled the feudal hierarchy and its associated *gult* rights, removing private ownership of lands by individuals and religious institutions and divesting them of any rights to labor or resources. The informal caste system that previously prevented many people like blacksmiths, potters and some religious groups from owning land was also abolished. The latter proclamation formalized peasant associations as the lowest and most local form of governance. One of the major duties of these peasant associations, which are still maintained today, is the division of land and

resources within an association's administrative area (*kebele*) among families on a supposedly equitable needs basis. The net effect was and is, ideally, the production of an officially classless egalitarian system that guarantees access to land to all residents and put the peasant association members in charge of orchestrating local labor projects and resource redistribution, replacing roles typically held by royally sanctioned elites and clergy. Subsequently, many former royally-sponsored churches saw their revenue streams and labor pools dry up, and their support became reliant on the production capacities of their ordained membership and the goodwill of the local communities. In response to the droughts suffered during the Derg regime, the government also accelerated land resettlement programs, first conducted during the mid-20th century (Shinn and Ofcansky 2013: 261-262). Though residents were not questioned about resettlement within the research area, it is known that many people were removed from the Wollo region (Dejene 1990: 96).

That such royal churches were once so socially and economically significant in their landscapes is reason enough to make them attractive subjects to archaeologists. Gännäta Maryam church was initially attractive to the Solomonic - Zagwe Encounters project because of its role as a royally-associated church straddling the ethnic and historical divide of the Agaw ethnic group/Zagwe Dynasty and Amhara ethnic group/Solomonic Dynasty. The local oral tradition also holds that the area once hosted the royal court of Yekuno Amlak. If so, it would be one of the first post-Lalibelan royal sites to be studied outside of later fixed capitals like Gondar. The opportunity to study such a possible site, or any site associated with an early royal church of the Solomonic Period was the primary drive for this thesis, pursuant to calls made by Finneran and Tribe (2004) regarding the potential for and significance of such work.

As this thesis shall make clear, however, once fieldwork began the focus swiftly changed to understanding the formation processes that went into producing the current landscape. It became clear that only through this line of research would it be possible to understand the archaeological record of the area and evaluate its relevance for understanding the role royal churches played in the early Solomonic Period. As it turned out, the former concern of understanding formation processes became the primary focus of the project, while fully comprehending the origins of the local archaeology was



recognized as problematic, though perhaps instructive when viewed through the lens of a landscape formation processes study.

### **2.3. Previous research**

While there has been some interest in Gännäta Maryam in the past, much of the focus has been on the art history and architecture of the church, rather than the local archaeology. Likewise, interest in the church itself has often been eclipsed in art history, architecture, and archaeology by the better known site of Lalibela. Despite the lack of focus, however, researchers have acknowledged that that the region around Lalibela, and indeed the study area of Gännäta Maryam, are deserving of greater attention (e.g. Finneran and Tribe 2004; Finneran 2009). This thesis, then, has been done in partial fulfillment of an acknowledged need to expand research in the area to include archaeology and the wider context of the region's important historical centers.

The existence of the rock hewn churches in the region first came to the attention of Europeans following Francisco Alvares' (Beckingham and Huntingford, eds. 1961) description of Lalibela during his diplomatic mission to Ethiopia in the 1520s. Scholarly attention to the region, however, did not begin in earnest until the mid-20th century. The first modern detailed descriptions of the Lalibela church complex and nearby regional sites and features, frequently including Gännäta Maryam, were published by Monti della Corte (1940), Miguel (1955), and Bianchi Barriviera (1963) among other more regionally broad (e.g. Buxton 1947; Gerster 1968) or less scholarly (Bidder 1959) works. Such research though, was quite preliminary and descriptive. For example, during the 2009 *Centre français des études éthiopiennes* (CFEE) mission to Lalibela, of which the author was a participant, it was discovered that some of the archaeological/architectural features described by Monti de la Corte, such as the "thrones of Yemrehana Krestos" were in fact natural features ascribed anthropogenic origins in local oral history.

The first "excavations" in the region were conducted by Angelini (1967), a specialist on architectural preservation who was sent to survey and study Lalibela on behalf of the UNESCO International Monuments Fund and the Ethiopian government



(see International Fund for Monuments 1967). His surveying included the clearance of a number of the rock-hewn trenches around the churches, recovering artifacts and revealing new features, though his intentions were not explicitly archaeological and his methods did not meet today's archaeological standards. As such, his contributions have perhaps done more harm than benefit to the progress of archaeological and historical research in the region.

Following this nascent period, research frequently took on a more localized and art-historical approach, focusing on particular churches and their artworks, while archaeological and regional research stagnated. Gervers (2003a, 2003b) and Lepage (1997, 1999, 2002, 2006), for example, spent much time analyzing the art and architecture of the Lalibela churches and the historical contexts surrounding their construction and meaning within Ethiopian history. Likewise, similar research was conducted around Yemrehene Krestos (Balicka-Witakowska and Gervers 2001; Girmah et al 2001), another Zagwe Period church 11 km north of Lalibela.

In 1975, Lepage published an extensive inventory and description of the mural paintings at Gännäta Maryam conducted just prior to the revolution. Heldman and Getatchew (1987) put much of this research into context, analyzing the significance of the Yekuno Amlak portrait and associated historical figures depicted in the church for better understanding the chronology and important personalities of the period. Balicka-Witakowska (1998-99) built upon the works of her predecessors, putting Gännäta Maryam church into a greater post-Zagwe historical context. She notes, for example, the presence of similar historical figures, including Yekuno Amlak, at Waša Mika'el church to the south in the historical region of Shewa (see Mercier 2002). She also notes the previously undocumented presence of inscriptions noting other historical figures who presumably wanted themselves associated with the church and its history.

In 2004, Finneran and Tribe first described the possible presence of a royal camp at Gännäta Maryam while emphasizing the potential significance of archaeological research at historical monastic sites for our understanding of Ethiopian history. In 2009, this author, along with Finneran, joined the CFEE mission to Lalibela. The goals of this field season were divided in two parts. The French team sought to produce modern, high-resolution digital maps of the churches and every possible anthropogenic landscape

feature around them. The purpose was to reconstruct the construction sequence of the churches by examining, when possible, the sequences of cutting and recutting of the rock in the area resulting in the modern landscape and churches. Importantly, their research seems to confirm suspicions that some churches were not carved *de novo*, but in many cases were the results of refashioning of older structures and that the landscape of the churches changed continuously throughout work there (Fauvelle-Aymar et al. 2010). Finneran, along with this author and colleagues Iyassu DeMissie and Abebe Mengistu, meanwhile, conducted regional surveys of the area documenting historical sites and monuments, artifacts scatters, and oral-historical narratives ranging for a dozen kilometers in many directions. This work included preliminary survey of Gännäta Maryam leading up to this thesis research, along with identification or re-confirmation of a number of historical sites. Preliminary conclusions of the work were published by Finneran (2009, 2011).

Contemporaneous to this research, Phillipson (2009) published a comprehensive book on Ethiopia's historic churches which synthesizes much of the current data on them and attempts to place them, the churches of Lalibela and Gännäta Maryam included, into the grander historical narrative of Ethiopia from the Aksumite period through the Middle Ages. Subsequent seasons of research at Lalibela by the CFEE included small excavations, including of a spoil heap associated with the carving of the churches and a cemetery. Their research again confirms the long and continuous use and re-use of Lalibela's historical sites and heritage (Bosc-Tiessé et al. 2014).

#### **2.4. Contemporary Gännäta Maryam: A general area description**

The following sections provide a description of the contemporary setting of the Gännäta Maryam area and its immediate surroundings in order to provide spatial context for the names and features discussed throughout the rest of this thesis (Figure 2.3). This section provides a general description of the area as a whole, particularly modern features of the town and church and major topographic features and areas referenced throughout

the rest of this work. The second section focuses on the study area and its geophysical features.

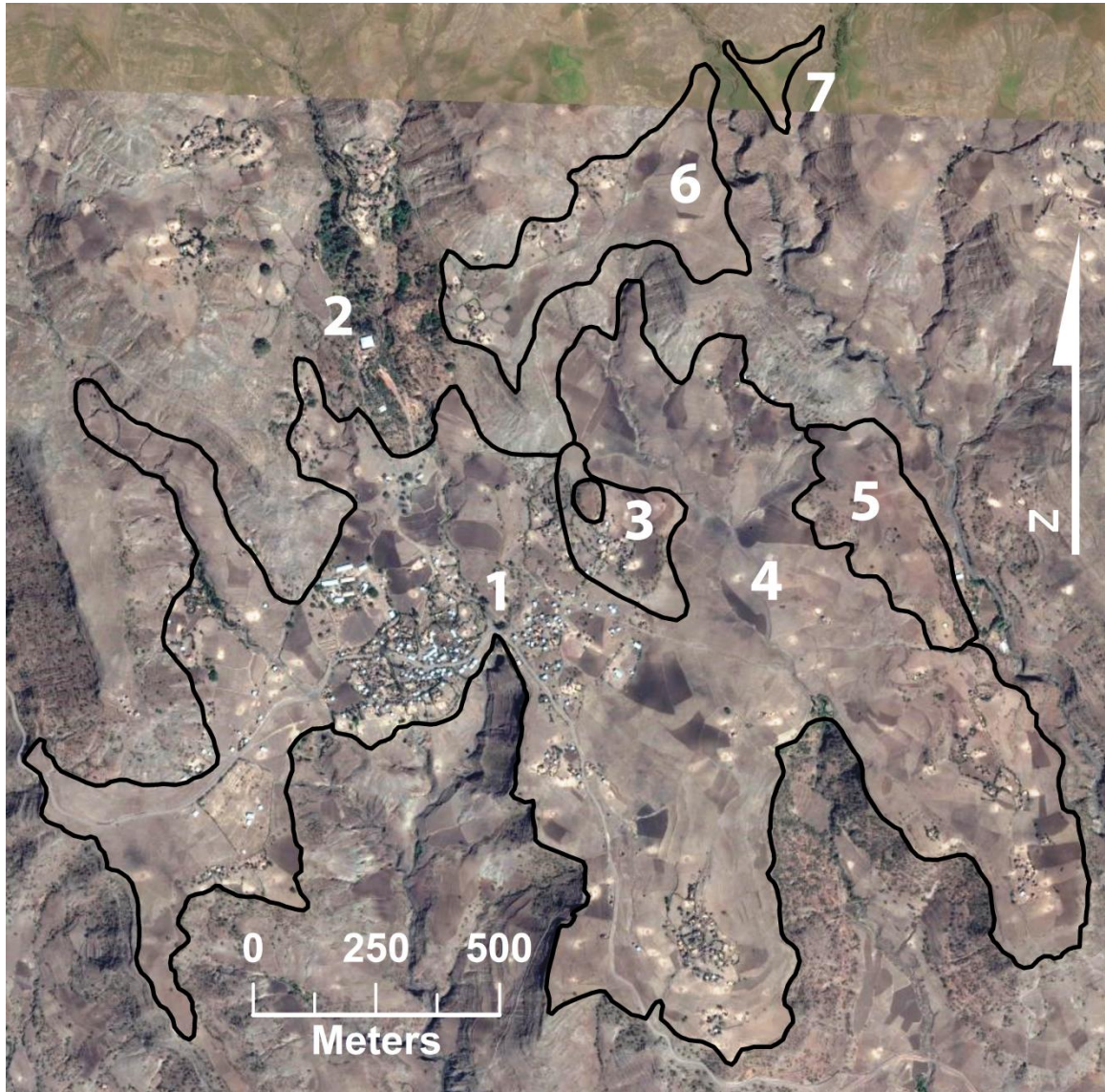


Figure 2.3. Important locations in the study area by terrace sequence ( $T_3$  and  $T_2$ )

$T_3$ : 1) Gännäta Maryam Village to right and left 2) Gännäta Maryam Church, beneath a protective tin roof, right 3) Hilltop of Tarla Terrara, left 4) Tabot Madera, extending roughly northwest to southeast between Tarla Terrara and Alem Doret 5) Alem Doret Hill/Ridge;

$T_2$ : 6) Agay Midir Terrace 7) Kiflie Mado Terrace

"Gännäta Maryam" as used throughout the rest of this thesis will be shorthand for the three geological strath terraces encompassing the study area, though in local parlance this designation refers exclusively to the modern village and historic church, both

associated with the largest physical area of the study area, the lowest terrace of this spur of Mount Abuna Yosef. In geological nomenclature, this lowest terrace is terrace three, or  $T_3$ , while  $T_2$ , two twin terraces about 100 meters in elevation above  $T_3$ , comprise the rest of the study area. The highest sequence of terraces,  $T_1$ , are small, rocky prominences and are difficult to access, leading eventually to an uninhabited ridge defining the mountain spur. These areas were partially explored, but were challenging to access, appeared heavily eroded down to bedrock in many areas, and were unlikely to contain archaeological traces relevant to the original project goals around Gännäta Maryam Church.

The large, lower terrace,  $T_3$ , is comprised of roughly three regions. The western region of the lower terrace is a fairly narrow, roughly east-west running section terminating on its eastern side with the modern village of Gännäta Maryam. This narrow section of terrace is punctuated by two ravines running north, the larger of which, just north of the village, houses Gännäta Maryam church nestled in the red tuff between the eastern and western segments of the upper terrace,  $T_2$ , the eastern section of which is also part of this thesis' study area. The ephemeral stream that waters the town during the rainy season mentioned above runs past the church, through the eastern side of the village, and over the terrace. Around the village east and west of the stream are the local *kebele* office, the school, clinic, weekly market, and other village amenities.

East of this feature, the terrace elongates greatly north to south into two peninsulas divided by the wadi. The terminal areas of the peninsulas are of little concern here as very few archaeological remains were identified. Rather, this thesis focuses on the northern half of this area of the terrace, around the wadi that divides it. The area has a number of important physical features and geological attributes, discussed further below. Here, names and general descriptions are provided.

The terrace here is an elliptical basin referred to throughout the project by its local name, Tabot Madera, a name encountered around other historic churches in the area referring to open areas where the *tabot* (tabernacles of the Ethiopian Christian Church) and other religious icons are or were brought out for Epiphany. To the north is the ascending wall of Agay Midir, the upper terrace, or  $T_2$ . The upper half of this basin, referred to as "Tabot Madera, Area A," or "TM: A" in figures, contained the largest

concentrations of surface material and is characterized by gently sloping fields divided by the dendritic gullies that feed the central wadi to the south (Figure 2.4-5). Surrounding the wadi is the alluvial plain likewise referred to as Tabot Madera, Area C. West of Tabot Madera is a low rise capped by a small hill or inselberg named Tarla Terrara (Figure 2.4-5). The hill provides a geographical break between the densely populated village area to the west, and the fields and homesteads of Tabot Madera to the east. Access to and from the village is either by a large footpath running south of Tarla Terrara and across the southern area of Tabot Madera, or over the saddle to its north that also runs up the escarpment to Agay Midir. To the east of the plain of Tabot Madera, running almost the entire north-south length of the eastern bound of the terrace is a low, flattened ridge referred to as Alem Doret, after the name given to one of the homesteads that once resided there. Alem Doret hosts the water reservoir mentioned previously, as well as two recently abandoned homesteads that will be discussed extensively in succeeding chapters. Like the saddle north of Tarla Terrara, a path also leads north up to the upper terrace of Agay Midir. East of Alem Doret, the terrain descends steeply to a small alluvial margin along the perennial stream mentioned above. Some pottery, which is likely modern, was found on this margin, though the whole area has been dramatically transformed by the construction of a cooperative farm used for growing fruits and saplings of useful tree species for participating farmers and so was not included in this research.



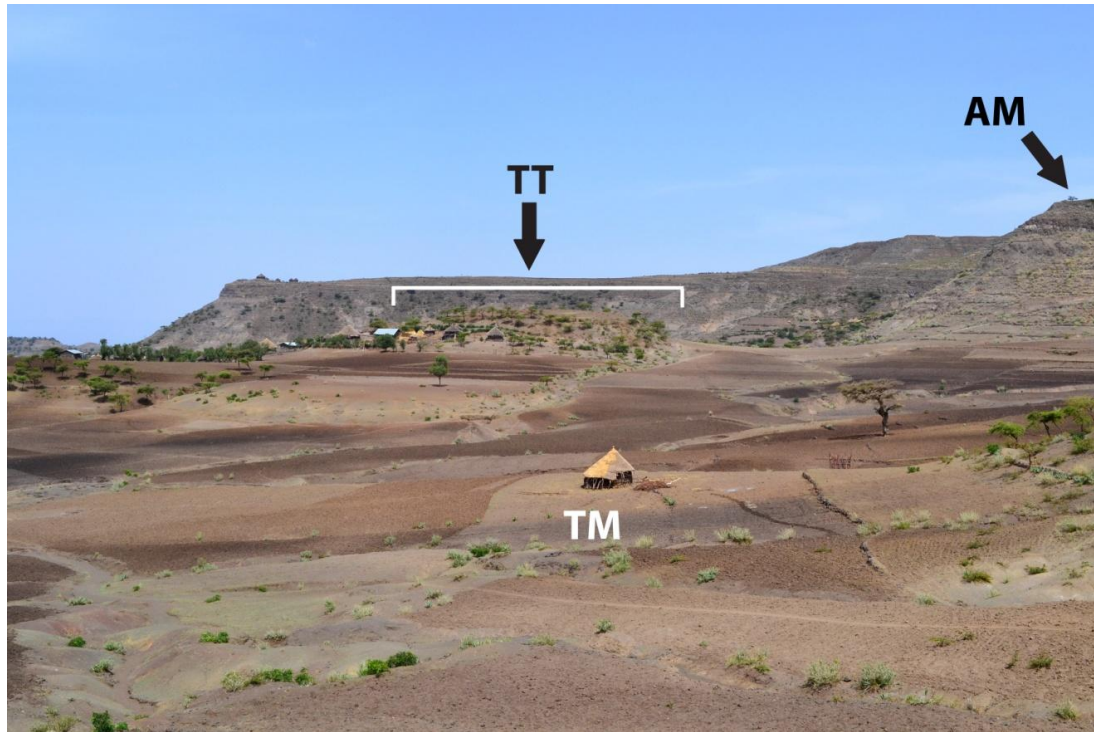


Figure 2.4. Looking west across Tabot Madera, Area A from Alem Doret to Tarla Terrara. TM: Tabot Madera. TT: Tarla Terrara. AM: Western spur of Agay Midir.

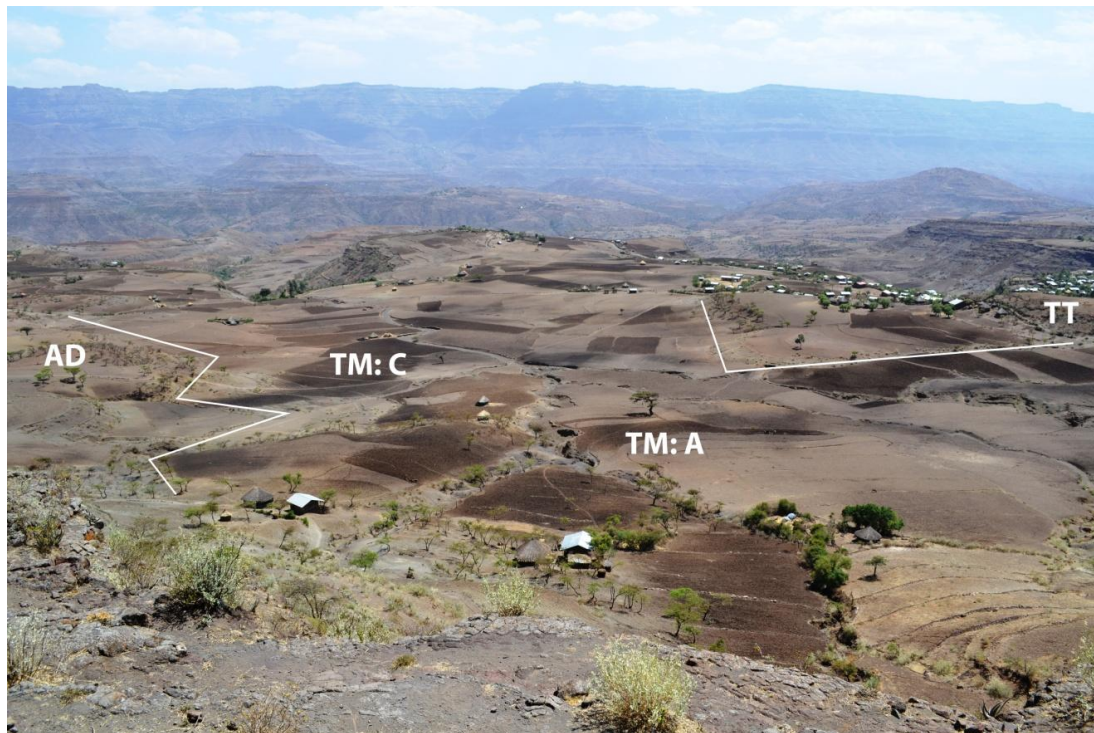


Figure 2.5. View of the lower terrace,  $T_3$ , centered on the wadi and its feeder-gullies. Tabot Madera, Area A (TM:A) is the gently sloping fields around the feeder gullies, while Tabot Madera, Area C (TM:C) is the land on either side of the wadi between the hills of Tarla Terrara (TT), right, and Alem Doret (AD), left.

Overlooking Tabot Madera to the north is the narrow, rocky terrace of Agay Midir, with footpaths to Tabot Madera at its southeastern and southwestern ends, as well as a footpath to the ravine separating it from Gännäta Maryam Church over its western flank. A number of fenced compounds dot the western end and northern margin of the terrace where it meets the ascending scarp of the next series of terraces ( $T_1$ ), which as mentioned above, were not included in this study. According to Habtamu Tesfaye, a colleague and government supervisor during the second field season, the name Agay Midir identifies the place as one where a particular variety of teff (*Eragrostis teff*) is grown, though no inquiry was made as to whether it is common practice or not today.

A path follows the eastern edge of Agay Midir around the head of a steep erosion gully leading to a small delta-shaped terrace named Kiflie Mado. This terrace is defined by two such gullies forming ravines which join just below the terrace in a steep ravine leveling off to form the perennial stream at the eastern boundary of the lower terrace. Though the terrace was considered of interest during preliminary surveying in 2009, by 2012 it had been significantly transformed by land reclamation projects described in Chapter 4. Regardless, during the 2013 field season, some artifact scatters apparently undisturbed by the reclamation work were rediscovered here and the area was reincorporated into the project. Unlike the other areas where surface collections and excavations were undertaken, artifacts and features at Kiflie Mado were on the ascending slope above the level terrace surface just before the colluvial soils transitioned to lithic Leptosols and bedrock. It was thus the steepest area studied in the main research area. The gradient of the soil slope has been interrupted and leveled slightly with recently constructed bank-and-ditch retaining features, while recently constructed lynchets have been placed along the rocky and uncultivated areas of the slope. Saplings have been planted in some areas behind lynchets where there is sufficient uncultivated soil. As the excavations revealed, though bedrock outcrops were observed on the soil slope, soils could also be quite deep in places, possibly retained by natural and anthropogenic features like the outcrops and stone walls.

## 2.5. Gännäta Maryam and its people

### 2.5. (a) The population and settlement pattern

As will be made clear in Chapter 4, the Gännäta Maryam area has transformed greatly in the past few decades. This section attempts to provide a basic overview of the study area's residents, their lives, and practices. This will provide a general sense of the people that live and work in the area, and their regular routines, saving more detailed discussions germane to this dissertation for the relevant chapters.

According to the *kebele* office located in Gännäta Maryam Village, the Village has about 1500 residents, though this seems quite large and may be mistaken for the population of the *kebele* itself. The population of the terraces in the study area excluding the village is estimated by the office to be slightly greater than 100 individuals. The emergence of the village is quite recent, however, aerial images and oral histories documenting its emergence out of a previously agricultural landscape within the past 30 years or so (see Chapter 4).

Previous occupational patterns according to the imagery and local accounts were more consistent with that observed outside the modern village. On the narrow upper terraces and in some locations on the lower terraces, houses and housing compounds (here referred to as homesteads to distinguish them from the small, single-building homes) frequently hug the colluvial scree areas that mark the transition from agricultural land to the ascending scarp faces. Elsewhere, residents take advantage of rocky high points such as the relict inselbergs at the ends of the two peninsula of land extending from either side of Tabot Madera. No less frequently, smaller, isolated houses and even a few homesteads are evenly dispersed across the open fields rather than concentrated into marginal areas. As demand for agricultural land expanded alongside the growth of Gännäta Maryam Village, some residents like the former residents of Alem Doret left their homesteads and permitted it to come under cultivation.

The residents speak Amharic and though they were not asked, likely claim an Amharic identity. As mentioned above, however, this is a historic phenomenon that emerged sometime in the second millennium AD. Residents, however, clearly view themselves in contrast to their neighbors in Lalibela. Because of the historical origins of



the Lalibela churches and Gännäta Maryam, the two communities possess some sense of distinctiveness and differing allegiance from one another. Many of these issues came up while assisting with the production of an English-Amharic language informational poster to be placed outside the Church so that the community could express its own history to visitors without the perceived biases or ignorance of non-resident tour guides. According to the local clergy, some Lalibela priests view Yekuno Amlak as little more than a conqueror of the Lalibela dynasty, many of whose kings were granted sainthood. At Gännäta Maryam, however, Yekuno Amlak is venerated in the Church similar to a saint. Residents like the blacksmith/potter family, headed by the patriarch *Ato* Ababu Gubay, claim descent from the followers of Yekuno Amlak and many residents firmly believe he resided in their region for some time during or after his conquest. They view themselves as having a special connection to historical events and figures in a positive light not shared by the residents of Lalibela, whose cultural and historical allegiance appears to lie with the Zagwe-period kings.

## **2.5. (b) Occupations and agriculture**

The population of region may be divided into three classes. The subsistence agrarian population undoubtedly makes up the majority of people living in this rural area. Even the majority of village residents are still engaged in agriculture, many claiming they came to the village for the opportunities it affords, while they still maintain their farmland elsewhere in the area. Related to them are the religious figures associated with Gännäta Maryam Church. In the Ethiopian Tewahedo church, certain clergy positions like deacons, with some caveats, may have families and engage in mundane activities while simultaneously working for the church. Deacons, then, comprise a respectable part of the population, along with priests and monks. The estimated population of church officiates according to local informants was about 100 people. Many are engaged in agrarian lifestyles identical to the lay public. This is not atypical in the history of the Ethiopian church, though the percentage of clergy involved in subsistence activities has

likely increased after the removal of *gult* rights, which could have once subsidized non-agrarian lifestyles for the clergy.

The third class of residents is the artisans like blacksmiths and potters. These hereditary occupations once formed a caste in Ethiopian society that excluded them from certain privileges enjoyed by the peasantry, such as the right to own land, though their skills could lead to patronage from lords and ecclesiastic institutions. Post-monarchy reformations abolished recognition of the caste system and attempted to remove the social stigma attached to artisans. Traditional prejudices are still sometimes expressed, however. During our fieldwork, some residents called blacksmiths and potters "buda," the term for one who can cast the evil eye, and expressed mild alarm when I and other team members ate with the resident potter/blacksmith family. Only one extended family of blacksmith/potters lives in the study area, where they claim to have lived for centuries, though others service the area by attending the weekly market next to the village. Following the land redistribution reforms, blacksmiths and potters were granted land for agriculture, though this had numerous implications for their ability to practice their craft, discussed in Chapters 4 and 6. The blacksmith/potter family we interviewed in our study area says they do practice some agriculture, though more out of necessity given the decline in demand for and profitability of their wares as the region slowly modernizes.

Virtually all residents of Gännäta Maryam then have ties to agriculture, either directly or via their extended families, though many supplement their family income with other activities. A young woman named Tigist, for example, assisted our project while also teaching at the local school and running a shop where she serves drinks like tea and coffee. Her parents and siblings, meanwhile, continue to farm in the region. Other residents also frequently supplement their income with other activities such as home gardening of produce and eucalyptus wood, rearing and rental of cattle to other farmers during the plowing season, the sale of prepared food and home-made alcoholic beverages out of their homes.

Traditionally, farmers would divide their land among their male children and if land was insufficient, younger siblings might join the church or move to areas where land was available (Hoben 1973). Today, however, many farmers complained of the degraded quality of the land resulting in chronically poor harvests and insufficient space and yields

to support them and their children. Many youths then, like some of those who worked for me, have graduated from the local high school and aspire to either enter college or move to cities like Addis Ababa. Many, however, also end up moving to towns like Lalibela, where they enter into service industries catering to tourists. The tradition of land reapportionment among kin has also eroded in the face of the Derg-era and later land reforms. Currently, the *kebele* office and Peasant's Association play an active role in land redistribution and local resource management, nominally to the equal benefit of all residents. To some degree this has supplanted the traditional model of landholding described by Hoben (1973), though casual conversation and observations in Gännäta Maryam suggest the Peasant's Association, being composed of local residents, has not entirely abolished conventional practices toward the communist ends they were designed to produce under the Derg.

## **2.5. (c) Agriculture and the agricultural year**

Time for most residents is divided between the needs of their agrarian lifestyles and observation of church customs. While Ethiopia has historically two rainy seasons (discussed below), the spring rains today are considered insufficient by most farmers in the area to support rain-fed agriculture. Thus, the primary agricultural season for residents in the study area is between May and August when the heaviest rain falls. Outside the study area, however, along the banks of rivers like the Takezze, agriculture remains possible in the spring where the accumulated water of the river catchment can be diverted to irrigation ditches through both rainy seasons.

Agricultural practice is still undertaken using traditional methods. In preparation for planting, field soils are broken up using an ard plow, known as a *maresha*, drawn by a pair of oxen. The plow is a pointed iron shaft pressed into the soil by the farmer while horizontal draft is supplied by the oxen. Because of the plow's form, it does not overturn soil so much as it simply breaks it up (Gebregziabher 2006). Fields may be plowed two or more times depending on the compaction and needs of the soil and intended crops (Nyssen et al. 2000: 199; Gebregziabher et al. 2006: 133). Plowing depth may vary

(Nyssen et al. 2000: 122; Gebregziabher et al. 2006: 113), but depths in the study area measured in shovel tests and excavations averaged about 15 cm. Most crops grown in large quantities are sewn by broadcasting the seeds and may be plowed again to help cover them.

Plowing is normally conducted just prior to planting, timed to the beginning of the rainy season. Vertisols (see below), however, pose a unique problem due to their high clay content and are cultivated differently. Because the clay content of Vertisols and vertic soils allows them to hold moisture longer than many other soils, heavy rains can waterlog the soil and drown seeds and seedlings if they are planted on Vertisols like they are planted on other better draining soils. Generally, Vertisols are plowed early and with more passes than other soils ensuring the clay is sufficiently broken up to allow deep and even water absorption. When farmers plant their crops near the end of the rainy season, they grow on the residual moisture held by the clay (Erkossa et al. 2006: 201, Astatke et al. 2002; pers. interviews with residents). This prolonged exposure of the loose soil to rain without protective groundcover, however, comes with costs, and as will be discussed in future chapters, contributes to erosion and degradation of the landscape.

Field selection was historically based on soil depth (Hurni 1988) and fertility, often selecting between the vertic and cambic volcanic soils in areas like the modern alluvial plain and surrounding slopes. The complex of crops grown, discussed below, is selected based on the properties of the soil. Vertic soils, for example, can damage roots as they dry and crack, so are only suitable to a limited range of crops. As discussed in Chapter 4, however, growing population pressure strained the productive capacity of the land to provide for its people, leading residents to clear and cultivate increasingly marginal lands like the rocky hills of Alem Doret and Tarla Terrara in the study area. Likewise, nonproductive practices like fallowing have generally been abandoned, and a spiral of declining soil fertility and net soil loss due to erosion has been ongoing, exacerbating problems of food availability during periods of drought, for instance.

Traditionally, farmers practiced a limited range of field maintenance methods such as building low earthen bunds in some fields, and higher earth or rock terraces on others. These help to hold back some soil. However, it has only been with recent land reclamation projects discussed in Chapters 4 and 5 that more substantial efforts at land

management, such as the use of ditches to recapture eroding soil, the use of live fencing for a number of sustainable advantages, and generally more consistent field terracing by different styles in different terrains have been widely implemented.

During the non-agricultural season, farmers concern themselves with other subsistence tasks. Children frequently shepherd cattle and other livestock on the stubble of the fields after the agricultural season and many will also attend school. Men and women will work to maintain field boundaries and erosion control features before and after the rainy season, as well as other household tasks such as resurfacing daub walls. One occupation for many residents is participation in the local food or seed-for-work programs administered by the local *kebele* office. A government building houses supplies of crop seeds. Residents can volunteer to participate in local land reclamation projects such as building lynchets on steep slopes, planting trees, and shoring up gullies against further downcutting. In exchange for their work, they receive grain for food and future planting. Some residents are also involved in a local agricultural co-op on the east side of Alem Doret along the perennial watercourse there. There they cultivate fruit trees and other useful plants. There are also extensive operations to grow saplings of useful tree species which can be distributed among co-op members, sold to non-members, and used in local land reclamation projects.

Likewise, the local clergy may also employ people in activities related to the church. During the period of research, residents helped build a storehouse and aspiring museum space adjacent to the church. They also helped cut back and terrace the hillslope adjacent to the Church, allowing cars to drive and park closer to it in the hopes this might attract more tourists. Incidentally, this activity also exposed a forgotten cemetery, discussed in Chapter 4. Residents were not asked if they materially compensated for this work, however, or if the compensation was of a more spiritual variety.

Throughout the year, the majority Christian population follows the observances of the Church, dictated by custom and proclamations of the local clergy. In particular, a number of saints' days and other holidays are regularly observed and often involve fasting, abstinence from agricultural labor, and attendance at church services. Weddings, funerals, and other major life events also frequently revolve closely around the Church.

## **2.6. Geology and geomorphology of the Gännäta Maryam region**

The Gännäta Maryam study area is located near the terminus of a southeastern spur of Mount Abuna Yosef (Figures 2.1, 2.6). Mount Abuna Yosef and its surroundings comprise one of a number of large mountainous areas which together form Ethiopia's "western" highlands. The extent of the highlands is defined by the steep escarpments that drop to the Rift Valley features of the Danakil and Afar Depressions to the east, the Awash River Valley to the south, the Red Sea coast to the north (in modern Eritrea) and the more gradual descent to the lowlands of South Sudan to the west. Mount Abuna Yosef itself is a relict of the region's former shield volcanoes bounded by the Takezze River Valley to the south and west, the Danakil Depression to the east, and a gradual transition to the Tigray Plateau to the north.

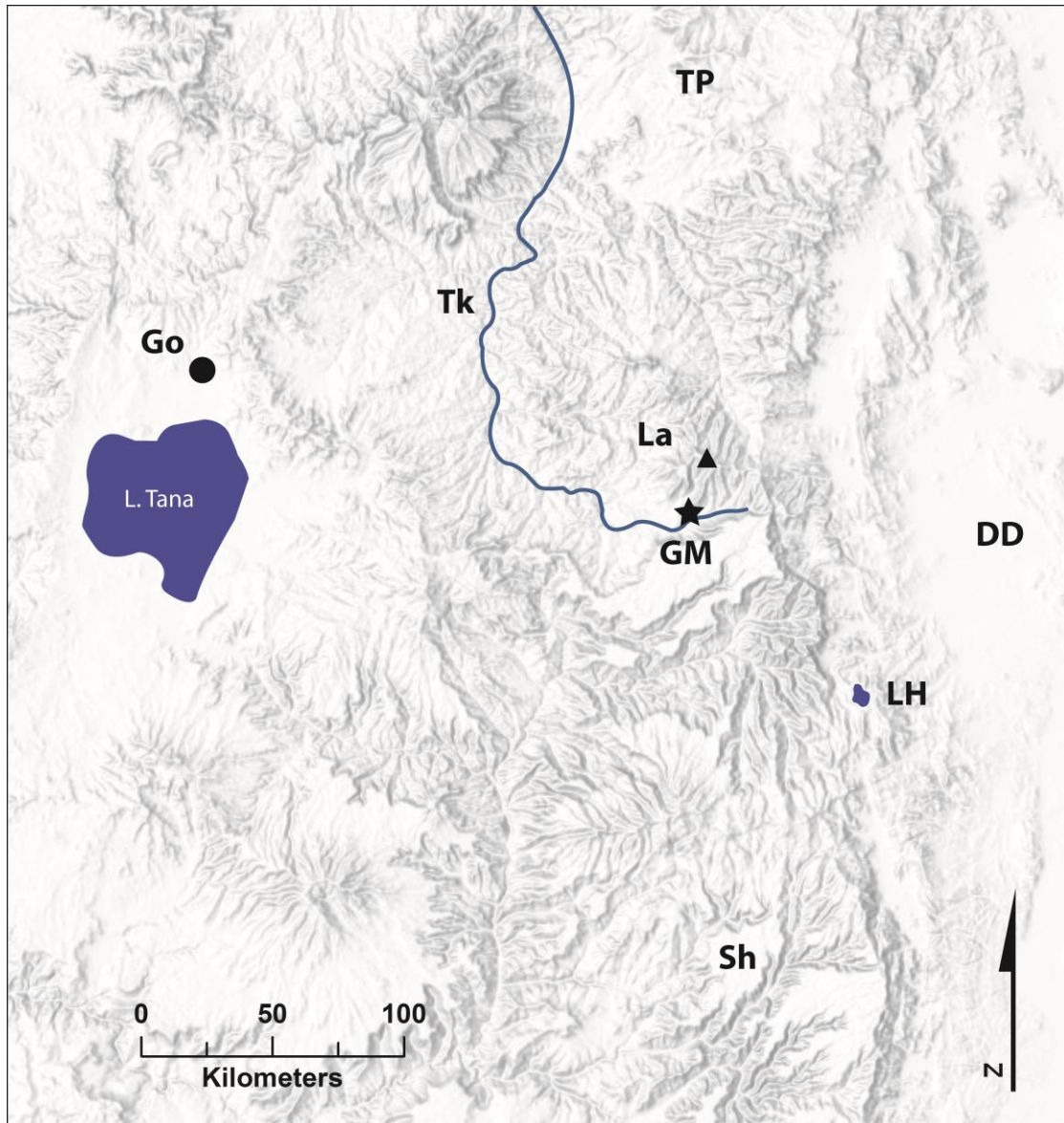


Figure 2.6. The Western Highlands of Ethiopia around the historic Lasta region. La: the historic region of Lasta, with Mount Abuna Yosef marked by a triangle. GM: Gännätä Maryam study area marked by a star. Tk: the Takezze River flowing from the valley below the study area, through modern Amhara Regional State into Tigray Regional State. TP: The Tigray Plateau, part of the historical region of Tigray. Sh: region of the historic kingdom of Shewa. LH: Lake Hayq. Go: Gondar, early-modern capital of Ethiopia. DD: Danakil Depression, sub-sea level salt desert and volcanic plain.

Decades of research have gone into describing and characterizing the tectonic and volcanic activity which came to dominate the geology and geomorphology of the Ethiopian highlands (e.g. Mohr 1971, 1983; Mohr and Zanettin 1988; Arndt, 2005). Through the later Paleogene Period, until roughly 23 million years ago, fissures formed in East Africa's Precambrian bedrock, signaling the birth of the African Rift Valley. These fissures rapidly exuded mafic, tholeiitic flood basalts, some reaching several

hundred meters in thickness. Through the Oligocene-Miocene transition, defining the end of the Paleogene, the plate margins were uplifted, flood basalts continued to flow, and shield volcanoes came to dominate the growing highlands throughout the Miocene and Pliocene Epochs (c. 23-3.5 mya). These shield volcanoes continued to blanket the terrain with increasingly alkaline basalts, and produced pyroclastic flows of felsic material forming strata of tuff and ignimbrites, which would later play a role in Ethiopia's ceramic tradition, discussed in Chapter 6. Other silica-rich minerals like rhyolite, obsidian and chalcedony also formed as a direct or indirect result of this later volcanism, providing important raw materials for Ethiopia's lithic tradition.

As the Ethiopian highlands rose to their current heights, erosion simultaneously cut through the tabular horizontal to subhorizontal strata of permeable and less permeable rocks. During the Pleistocene, glaciations occurred around the highest summits of some of Ethiopia's relict shields, weathering them and depositing moraines (Hastenrath 1977; Grab 2002). The grinding of the glaciers, their subsequent melting, and continued rains before and since, have sculpted Ethiopia's modern terrain features. The most visually striking are the expansive flat plateaus and smaller buttes, locally known as *amba*. These flat surfaces are the result of fluvial down-cutting and the differential erosion of hard and soft rock strata (Nyssen et al, 2004: 285). Not uncommonly, heavily eroded or decomposing inselbergs of the largely disappeared overlying strata are still visible dotting these otherwise flat landscapes. Related features (Nyssen et al, 2004) are the stepped geological terraces and benches skirting the edges of the larger elevated landforms which have historically provided temperate arable land and easy navigation across the highlands, avoiding the hot, malarial lowlands and the exposed alpine peaks. Pediments, low graded erosional surfaces abutting more steeply graded hills and mountains are also common, though there may be some confusion with aggradational surfaces (piedmonts) owing particularly to their unusually concave profile (Berakhi and Brancaccio 1993: 103).

Few if any geological surveys have studied the immediate vicinity of Gännäta Maryam in detail, though its nearby neighbor, Lalibela, has received some attention. Based on geological maps of the area (Kazmin 1972; Merla et al. 1979), and their related geographic settings, what is true for Lalibela likely applies to Gännäta Maryam at a



general level of detail. Both reside on adjacent spurs of Mt. Abuna Yosef on the lowest geological terraces of the mountain at about 2300 meters a.s.l. The two are separated by a headwater of the Takezze River and the backside of the spur on which Gännäta Maryam resides may be seen from Lalibela. It is even possible to see the same sequences of terraces and scarps from one spur looking toward the other. According to Merla (1979) and Delmonaco et al. (2010) (see also Mohr and Zanettin 1988), the lowest rock strata of the mountain are composed of weathered olivine-rich basalts with sporadic tuff and agglomerates. The terrace surfaces at Lalibela and Gännäta Maryam are largely basic basalt flows and scoria. These are capped in areas by the prominent rosy-red tuff and occasional pyroclastic bombs into which the churches of Lalibela and Gännäta Maryam have been carved. Precipitates of calcite and silica have formed within these strata and are frequently found in Gännäta Maryam as gypsum and calcite crystals, low and high quality cherts, quartz veins, and small chalcedony nodules. The scarps and treads rising above the churches and forming the remainder of the mountainous spurs rising to a height of about 3200 meters a.s.l. are a mixture of alkaline rhyolites and trachytic alkaline basalts with acidic ignimbrites and tuff. Additional historic churches such as Asheten Maryam, Emakina Medhane Alem, and Lideta Maryam, have been hewn from or were built in caves within these uppermost strata overlooking the terraces of Gännäta Maryam and Lalibela. Like the aforementioned ambas, on many of these terraces, low inselbergs of soft bedrock like Tarla Terrara still remain, belying the materials that once filled those elevations prior to their erosion and the formation of the region's characteristic stair-step morphology.

As will be discussed in later sections of this thesis, particularly Chapters 3 and 5, the local geology and geomorphology of Gännäta Maryam (Figures 2.11, 2.12) and the region have played important roles in the area's history, from its material culture to its agricultural practices. Similarly, the geomorphology has contributed significantly in tandem with other factors to produce the disturbed and fragmented archaeological record examined within the scope of this research. Figures 2.7, 2.11, and 2.12 below provide physical and topographical context for the Gännäta Maryam research area.

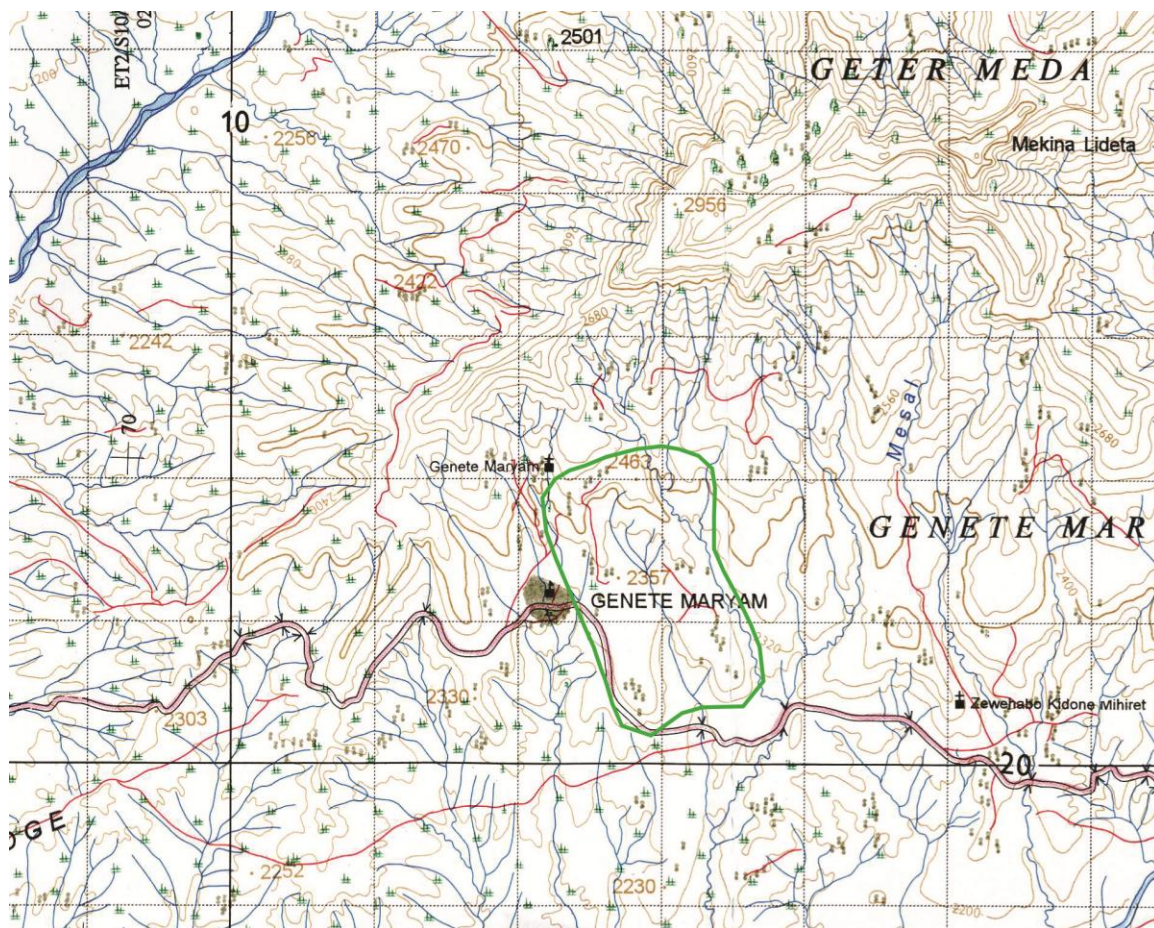


Figure 2.7. Topographic map (1:50,000) (Ethiopian Mapping Authority 1996: Series ETH 4, Sheet 1139 A1) of the mountain spur on which Gännäta Maryam rests. The terraces of the study area (all east of the village) are circled in green.

## 2.7. Hydrology

The hydrology of the Gännäta Maryam region is dominated by the watershed of the Takezze River (Figure 2.1 above). The primary headwater of the River flows roughly east to west below the village terrace to the south, while a secondary headwater flows behind the mountain spur, separating it from Lalibela. During the drier months, the waters are very low and shallow, measuring little more than a few meters wide and far shallower. Few visible perennial water courses feed the dry-season rivers, though numerous deep, steep-sided wadis cut through the sides of the scarps and meander through the terrace and valley floodplain alluvia. During the wetter months, these catchments can swell, impeding transportation historically and to the present.

The study area at Gännäta Maryam possesses three major alluvial features. First, beginning just to the northeast of the church is a steep channel that cuts through the soft red tuff from which the church was carved. For the few months prior to the rainy season, the bed contains shallow, stagnant pools of water and is virtually desiccated near the town, where the channel broadens over the bedrock. A few natural springs, a common feature of the highlands where permeable and impermeable rock strata meet, spill out at the edge of the escarpment in the middle of the village, where a small cistern has been constructed to maintain the water in larger volume.

Just east of town is the second alluvial feature where the northern end of Tabot Madera is defined by the dendritic branches of the research and agricultural area's main watershed (Figure 2.8). Small gullies cut through the escarpment scree and descend into the fields, where they are generally shallow and contained by banks of vesicular bedrock. The fields show strong evidence for erosion and deflation, near to the level of the bedrock, in many areas here. As these drainage channels join together, they enter a broad alluvial plain in the middle of the terrace, cutting a channel about 1.5 to 2 meters deep and a little over 5 meters wide in most places through alluvium, vertic clay, and outcrops of vesicular bedrock before meeting the edge of the terrace scarp. Local informants, farmers who own land along the channels, agree the channel meanders during the rainy season, evidenced by point bars and undercuts, discussed in Chapter 5. The bottom of the wadi throughout its main and branching courses is covered in coarse, dark sand. Though a formal analysis of the composition of this sand has not been undertaken, close examination, supported by common sense, suggests it is composed largely of minerals eroded from the surrounding volcanic mountains: amphiboles, pyroxenes and/or olivines, with additional inclusions of calcite and/or gypsum crystals, quartz sand, and occasional chips of rock and oxidized metallic nodules. This same sand is used as temper in local ceramics according to the local potters and confirmed by analysis.

Finally, to the east, bounding the two larger terraces of our survey area from the rest of the mountain is a large, perennial stream cutting through a steep bedrock ravine (Figure 2.8). The two forks at the head of this ravine define the deltaic terrace of Kiflie Mado, another part of the research area. Though the source of this perennial water source was not sought out, it is likely fed by one of the perennial springs that drain water

percolated through cracks or porous rocks of the ascending scarp. Informants from Gännäta Maryam confirmed that when insufficient water is available from the sources in town, water can be acquired from this source throughout the year. Within the past decade, a cistern on the southern end of Alem Doret hill draws water from this source and pipes it into town.

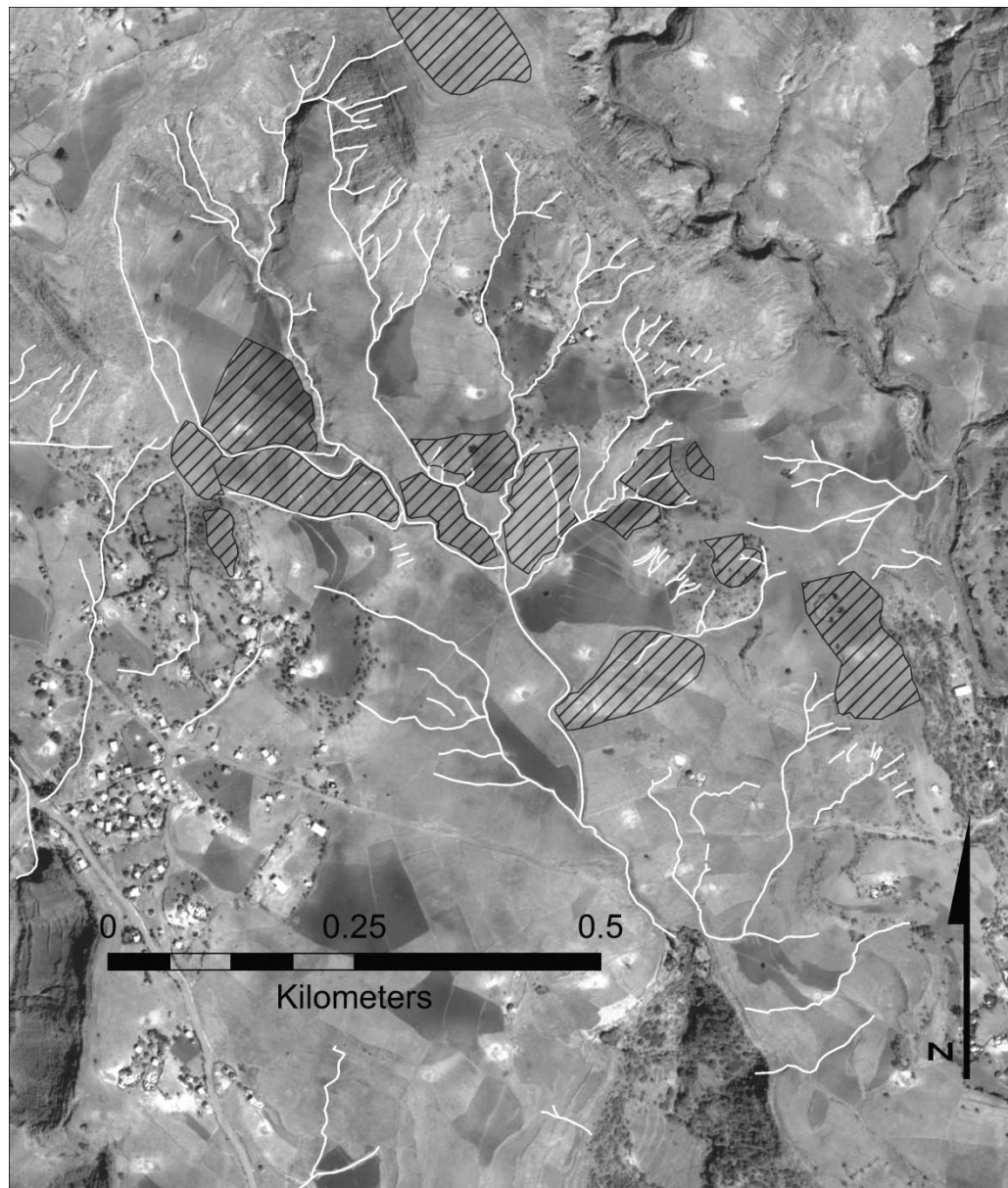


Figure 2.8. Study area watershed: seasonal wadis, gullies, and other significant erosion channels. Hashes represent areas where surface artifacts were observed within this map frame (a few small surface artifact scatters were observed beyond the map frame, but were not studied further in this project).

## 2.8. Geomorphology and pedology of the study area

A critical component of understanding the disturbed contexts at Gännäta Maryam (their formation processes, see Chapter 3) is an understanding of the geological and morphological landscape features with which they are associated (Wells 2001: 108). Once artifacts and features are seen in the context of their geomorphological setting, it is potentially possible to understand the formation processes that may have affected the archaeological remains and perhaps the chronological relationships among their formations and deformations (Wells 2001: 108). The following provides a localized description of the pedology (Figure 2.11), topography and bedrock geology (Figure 2.12) of the study area as it existed at the time of research. Data is based on observations from surface surveying and aerial images, as well as the results of shovel tests and excavations. The cumulative results of these intrusive methods are incorporated here, but a detailed discussion of the methods and particular observations for individual shovel tests and excavations are reserved for the relevant discussion of research methods and results in Chapter 4 and Appendix A. While this section provides merely a description, hypothetical reconstruction of the local landscape morphology and pedology and overall site history are reserved for the analysis in Chapter 5 following a discussion of locally active formation processes and their mechanisms of action.

Particular attention is given here to soils and topography, particularly vertic soils (Figures 2.9 and 2.10), as they have especially unique impacts on archaeological preservation. However, as soil analysis and classification was not a part of the original research design, and no fine-grained analysis exists for the research area, all soil classifications here are based on closest matches with standards set forth by UNESCO's Food and Agriculture Organization (2014) and similar taxonomic descriptions (e.g. Jones et al. 2013). The resolution of the classification of Gännäta Maryam's soils, like the classification itself, may not be as precise as that produced by a professional geological survey; however, at the scale of much of the areas' archaeological features and the level of detail to which the area's formation processes can be reduced, the resolution and precision produced for this project is sufficient for the project's current needs. Only if similar projects were to be produced in the future with a wider research area and more



detailed observation and analysis of formative processes might a finer-grained analysis of morphostratigraphy and soil taxonomy be needed, if at all.



Figure 2.9. Area of Vertisol soil with characteristic fissuring on an *amba*, or flat-topped mesa, near the study area.



Figure 2.10. Looking westward across Tabot Madera, Area A, from center. Vertisol fields stretch across the middle of the photograph, while cambic soil is present in the foreground. A gully divides the two. Scarp of Agay Midir in background.

In relevant literature on the region, Cambisols are frequently claimed to be the dominant soil order in the region (Asamoah, nd; FAO-UNESCO Digital Soil Map of the World, 2007; Friis et al. 2011: 21, Figure 5), defined as moderately developed soil complexes with incipient horizon formations (IUSS Working Group WRB 2014: 143-144). However, there appears to be some disagreement, as other sources classify the same region as dominated by Leptosols (e.g. Jones et al. 2013). Based on observations of the study area, this disagreement probably stems from the apparent association of soils, underlying geology and topography, and the swift transitions from one composition to another in small spaces. The highly eroded nature of the landscape also likely contributes to a perception of a great extent of Leptosols. Both Leptosols and cambic soils, if not proper Cambisols themselves, are common in the study area (Figure 2.11).



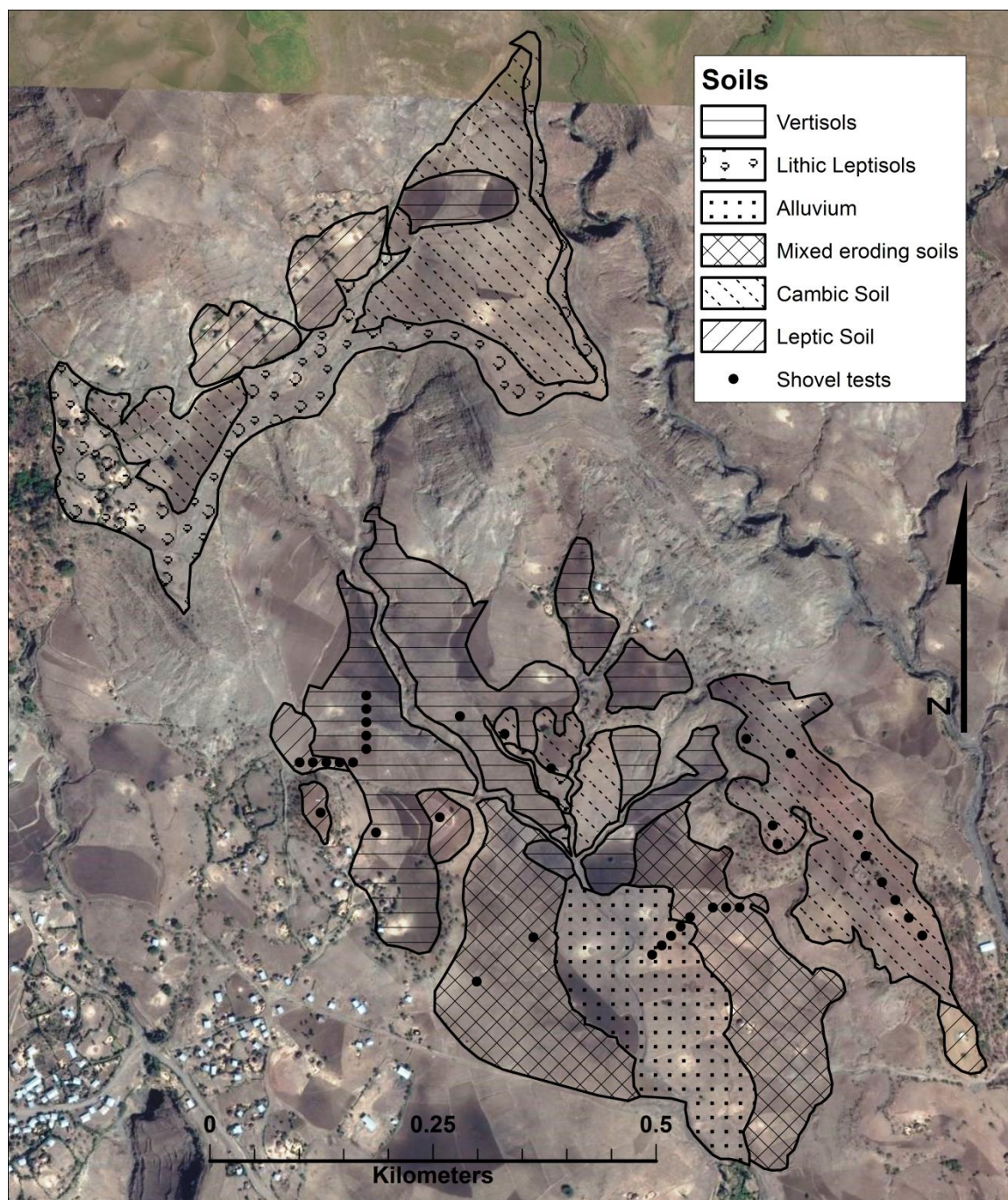


Figure 2.11. Surface soil map of the study area with shovel tests shown for reference. The map does not classify soils further northwest in Tabot Madera because shovel testing and, to some extent, walking, were not possible there as farmers had already begun to plant these fields during fieldwork.



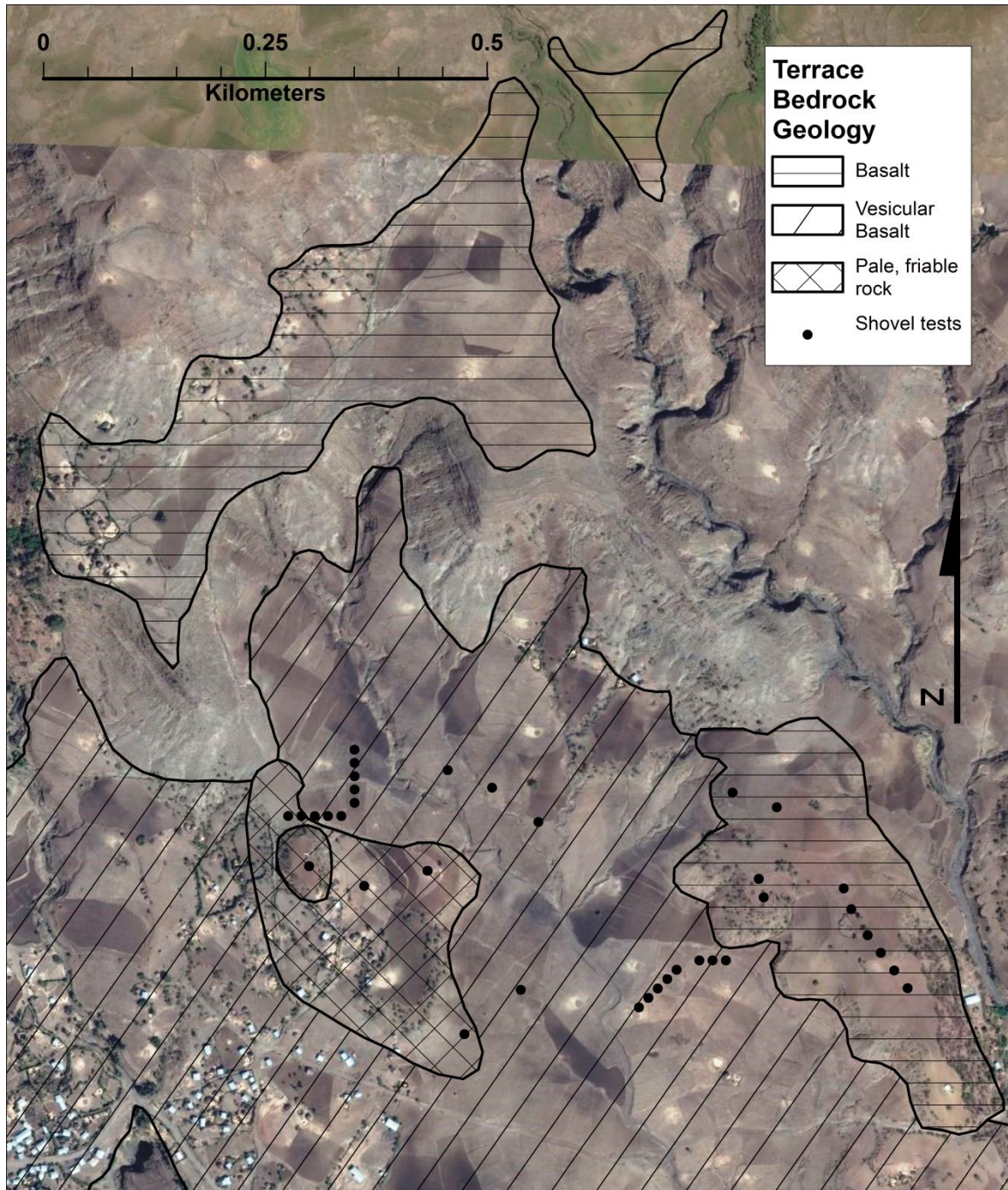


Figure 2.12. General subsoil geology of the two terraces of the study area with shovel tests shown for reference. These geological classes represent the majority of rock types exposed on the surface or in excavations. The classifications, however, may include more than one strata of similar rock types as identifying and classifying every individual rock strata composing the study region was not part of this project or necessarily relevant.

Rock outcrops on the lower terrace,  $T_3$ , suggest the terrace tread is a vesicular basalt overlain by other soils and relict geological features. Within the study area, such

features include Tarla Terrara and Alem Doret (Figures 2.11 and 2.12), both appearing to be inselberg relicts of the region's prior down-cutting and terrace formation. Both hills are geologically distinct from the vesicular basalt tread of T<sub>3</sub>, and also distinct from one another. Tarla Terrara and its surrounding elevation are composed of a pale, buff-colored friable rock that has not been identified. The surface of the hilltop is punctuated by small outcrops of dense basalt similar to that seen in the geological profile of the ascending scarp of Agay Midir. The soil on the hill is a thin layer of gravelly Leptosol with no clear horizon and very little soil formation. Leptosols are generally thin, poorly developed soils frequently found in highland environments (see IUSS Working Group WRB: 2014: 154; Jones et al., 2013: 55). As will be discussed in successive chapters, the hilltop was forested until recently, but was cleared, and then plowed for a short duration. It now has a thin erosion pavement and overall soil depth of about 20 cm in most areas before transitioning to regolith. Small rills along the break of the hill indicate ongoing erosion. Immediately adjacent to the hill to the east on the low rise before descending to the alluvial plain is a small area of vertic soil. The remainder of the hill is unplowed ground with an identical soil composition to that of the hilltop and a more developed erosion pavement. Along the western end of the saddle linking Tarla Terrara to the scarp of Agay Midir, this rock takes on a pale grey color, or is otherwise a different rock with a similar texture (Figure 2.4; Figure 5.5).

The geology of Alem Doret appears to be composed of the same or a similar basalt to the basalt outcroppings on Tarla Terrara, though Alem Doret lacks Tarla Terrara's pale, friable bedrock, at least in the northern half subjected to archaeological investigation. The paler soil along the southern end may indicate the reoccurrence of the same buff bedrock seen on Tarla Terrara, but this was not investigated as no archaeological remains were found in the area. The soil within the archaeological area is tentatively identified as a Cambisol (see IUSS Working Group WRB: 2014: 107, 143; Jones et al., 2013: 53), given the darker coloration, moderate soil and horizon formation and greater depth, often exceeding 30 cm before transitioning to bedrock. The chunky, friable nature of the bedrock, however, has resulted in numerous large rocks densely dispersed throughout the soil and "lithic Cambisol" or "cambic Leptosol" may also be appropriate designations.

The northern end of Tabot Madera, defined by the numerous gullies feeding into the central wadi is a mosaic of different features, though the entirety of the area was not surveyed for its geological and pedological composition so a complete analysis is not available and the relationship between various strata and soil features are imperfectly understood. The majority of the study area is defined by a thick (+70cm) layer of Vertisol clay (IUSS Working Group WRB: 2014: 171; Jones et al., 2013: 57) beneath a shallow vertic plowzone (Figures 2.10-11). Briefly, Vertisol clays are defined by their high percentage of smectic clay and associated shrink/swell properties (Mermut et al. 1996), discussed at length in Chapter 5. Here, they are incredibly dense, so much so that they were harder to excavate than the regolith on Tarla Terrara. Their clay content is also very high and was once used by the local potters (see Chapters 2 and 6). This soil was too dense and deep for shovel tests to penetrate entirely, so the underlying geology is uncertain, though is presumably the same basalts exposed elsewhere on the terrace tread. This vertic area does not cover the entirety of Area A, however, as some areas feature exposures of lighter cambic soil appearing to interdigitate with the Vertisol. Ongoing cultivation of the terrain, here, however prevented shovel testing to evaluate the relationship between soils and subsurface features. The majority of the Vertisol-dominated area is angled at between 1 and 4 degrees, though old soil bunds and field boundaries have likely played a role in shaping surface topography. The significance of Vertisols to archaeological preservation and what the Vertisol fields of the area may say about local environmental history will be covered extensively in Chapter 5.

Further north, along the margin with the ascending scarp, the soil also appears lighter in many areas, though this area was devoid of surface artifacts and was under cultivation soon after work began, so shovel tests were also not possible there (Figure 2.13). Personal observation and aerial imagery indicate the aggradation of colluvium in the upper margins of the fields where they contact the foot-slopes of the ascending scarp, suggesting that the fields there may be pediments or a colluvial drape. Additionally, the transition of lighter, rockier soils in the higher terrain descending to the large vertic areas may indicate an origin for the Vertisols in the erosion of the ascending basalt scarp rather than autochthonous formation. To the south of Area A, in the areas surrounding the



confluence of the gullies with the wadi, strata of vesicular bedrock are exposed in many areas (Figure 2.14).

Traveling down the wadi from its confluence, the bedrock drops about a meter while the soil surface grades from the dominant vertic clays to an alluvial plain (Figure 2.14). However, in some areas, Vertisol clay or bedrock are visible beneath the alluvium centimeters above the wadi bed. The wadi is characterized by relatively smooth, vertical banks and gradual meanders. The wadi measures about 1.5 to 2 meters deep and about 3-5 meters wide, varying in areas across its extent.

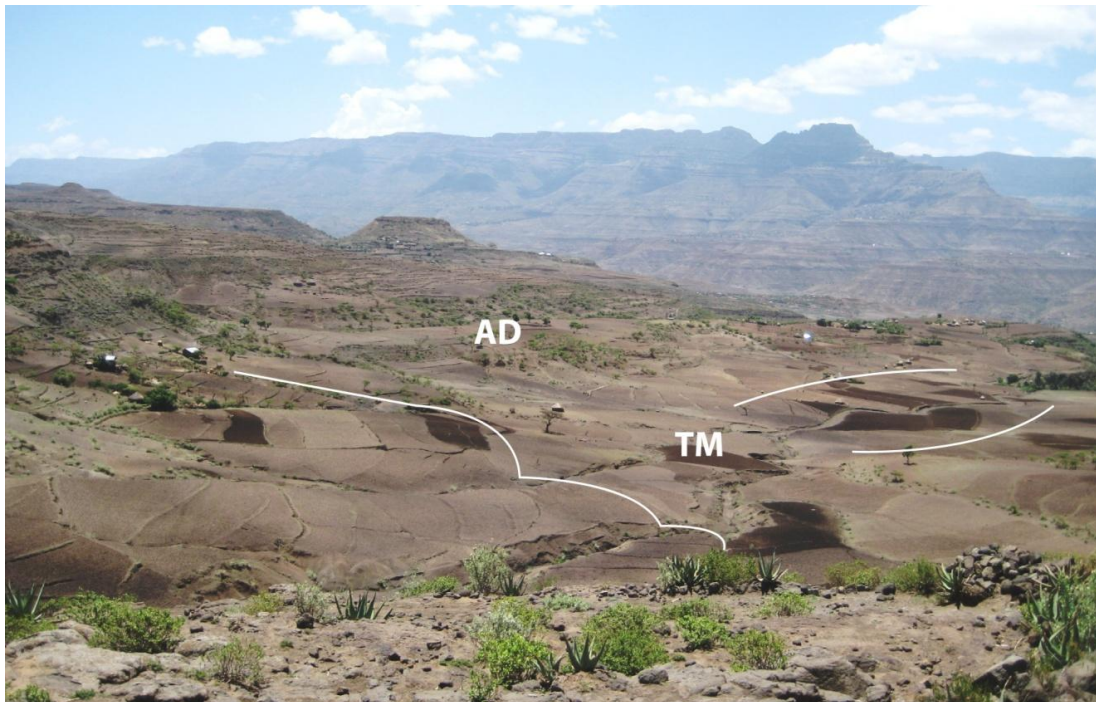


Figure 2.13. Image of study area from Agay Midir showing the area where shovel testing and excavations were not possible, below left of the white line. Alem Doret (AD) and Tabot Madera (TM) pictured at center. The floodplain of Tabot Madera lies between the two curved lines.



Figure 2.14. View south down the confluence of gullies where they cut through the vesicular basalt bedrock before they join the wadi of Tabot Madera in the center background.

East of the alluvial plain, the alluvium grades irregularly into the slopes of Alem Doret via a series of terraced fields. Some terrace walls rise in excess of a meter. Most fields exceed depths of 80 cm of fine, dark alluvium. In fields closer to Alem Doret, however, admixture with material eroding off the hill slopes is noticeable.

To the west of the wadi, a narrow drainage channel and field boundaries mark a stark transition from the dark alluvium to a gently sloping area similar to Tabot Madera, Area A. The western profile of the alluvial plain illustrates much better preserved alluvial strata than the eastern side, but unlike the eastern side is capped by a thick surface layer of vertic soil. In the southern portion of the alluvial plain, southeast of Tarla Terrara shovel tests on this sloping area reveal the extension of the hill's friable bedrock through this area. The soils are likewise thin and leptic in character, though they appear to grade gradually into darker, more cambic or vertic soils over unknown bedrock to the north. Aerial imagery, discussed further in Chapters 3 and 5, clearly show erosion of soils from the upper rises of Tarla Terrara onto the slope adjacent to the alluvial plain.

The terraces of Kiflie Mado and Agay Midir are geologically more simple and homogenous than that of T<sub>3</sub>. The treads are composed of a dense basalt with occasional

outcrops or surfaces of a reddish flowy vesicular basalt, which also seems to dominate the scarps behind them. Both terrace segments have expansive exposures of bedrock covered in lithic or skeletal Leptosols, essentially little more than thin dustings of gravel or coarse earth held in place by mats of vegetation. The homesteads abutting the ascending scarp appear to reside on a mixture of colluvium and poorly developed cambic soil. The soil on both terraces, where present, is similar in nature to that on Alem Doret, perhaps owing to the similar geology. Both are a dark, very rocky Cambisol (or possibly "cambic Leptosols"). However, in the eastern half of Agay Midir near the scarp the soil takes on a darker color with a more clay-rich vertic appearance much like the soil at the foot of Tarla Terrara Hill. Soil depth is unknown since shovel tests were not conducted on these two terraces; however, judging by their gradation from the areas of exposed bedrock and the walls that retain some of the fields, soil depths are likely thin, almost certainly less than 50 cm across most of their extent.

The archaeological deposits excavated at Kiflie Mado were not on the terrace itself, but at the top of the colluvial drape ascending the foot of the escarpment of T<sub>1</sub>. This escarpment, like that of Kiflie Mado, appears to be further dense basalt. It rises at a steep, though sub-vertical angle and is covered in rock and gravel. Narrow gullies dissect the steep scarp and colluvium, particularly to the west, bounding the archaeological site in this area. The soil of the colluvial drape is a similar cambic soil of the terrace tread below some 100 meters or so, but is perhaps a little rockier. Irregularities in the rock outcroppings of the slope and old and new retaining walls give the soil here irregular slopes, holding back significant amounts of soil in some areas, and exposing significant amounts of bedrock in others. The soils in the excavations here (Loci 7000 and 8000) were surprisingly deep, minimally over 50 cm, given the steep slope at Locus 7000 (~30°) and proximity of nothing but exposed bedrock meters upslope to the next terrace tread. The reason for this is likely due to the retentive properties of the walls and rock outcrops mentioned above, though many of these walls have been built so recently, it is difficult to tell what if anything was in place before them and how they may have changed the features of the slope. This topic will be returned to and speculated on further in Chapter 5.

## 2.9. Climate and ecology

Traditionally, northern Ethiopia has been dominated by two rainy seasons: the lesser spring, or *belg*, rains from February or March to April, and the greater *kiremt* rains from mid-June or early July to September. The consistency and volume of these rains is notoriously variable by year, season and location. When compared to historic climate data for Ethiopia prior to the establishment of a national meteorological unit, this led to a general perception that northern Ethiopia has been experiencing an increasingly arid climatic regime. The Climate Research Unit of the University of East Anglia (2014) for example reports that the summer rains once averaged about 70 cm, or about 70% of the annual rainfall from 1900-1930, and that this has subsequently declined to about 43 cm on average in the past few decades (see also Osman and Sauerborn 2002). However, at least some re-evaluation of such data suggests that the traditional perceptions of declining rainfall in regions of northern Ethiopia like the study area of Gännäta Maryam are misleading, due in large part to differences in research design or interpretation, particularly due to differences in temporal and spatial units of analysis, and the problems that arise from attempting to aggregate such disparate studies (Cheung et al., 2008). Some researchers like Cheung et al, (2008) and Seleshi and Zanke (2004) contend that contrary to these previous studies, rainfall in northern Ethiopia, including the Gännäta Maryam region, has been relatively stable over the recent past, though climatic variability by year, season, and small-scale locality are high, possibly increasing in the recent past, resulting in remarkable events like the droughts of the 1970s and 1980s (see also Mattson and Rapp 1991; Hulme 1992; Conway 2000). It is thus the default position of this research that factors like rainfall have been more or less constant within a set range of variability over the past century, and by extension perhaps the past few centuries, and that data about rainfall volume and erosivity today are roughly translatable to the recent past in the absence of better data. Currently, the study region lies in an isohyet receiving an average of 800-1000 mm of rainfall per year (data set generated by Hijmans et al. 2005, reported in Friis et al., 2011: 23, Figure 6).

Considering rainfall patterns and changes is important to this thesis because of the effects rainfall can have on rates of erosion and its sculpting of landscapes. Studying rain

drop size in adjacent Tigray Regional State, about 200 km north of Gännäta Maryam, Nyssen et al. (2005) noted the unusually large drop size of rain in Ethiopia. As drop size correlates to mass, and mass correlates to the kinetic energy of the falling drop, larger rain drops have greater potential for dislodging soil particles on impact. Similarly, variables like rain duration and intensity, combined with variables related to the soil and topography, affect the severity of erosion events and the distance soils and objects may be displaced. All these factors will be discussed at length in Chapter 5.

The ecology of the region as it exists today is commonly referred to as the "dry evergreen Afromontane forest and grassland complex" (Friis et al. 2011: 37-39, Figure 13) or similar. The study area is now heavily dominated by *Acacia* and woody bush- and grassland. As will be discussed in Chapter 3, this may not always have been the case (also, Friis et al. 2011: 70), but has likely come about due to centuries of forest clearance and intensive cultivation. Elevation, in addition to rainfall, plays a large role in the local ecology and climate of Ethiopia. The elevation of the primary datum established at the base of the large acacia at Tabot Madera is about 2,350 m.a.s.l., while the artifact scatter at Kiflie Mado is about 2,450 m.a.s.l. This elevation range places the area at the upper margin of Ethiopia's second of three indigenously defined climactic divisions by elevation: tropical (<1,500 m), subtropical (between 1,500 to 2,500 m), and alpine (>2,500 m) (Milkias 2011: 9). This middle subtropical zone may be thought of as the "Goldilocks" zone for traditional Ethiopian agriculture, providing an ideal combination of mild climate and adequate rainfall for the cultivation of a wide variety of crops, mostly above the malarial zone. By contrast, lower elevations are notoriously hot and dry, frequently occupied by pastoralists, while the highest elevations are cold, windswept plains and peaks where only limited agriculture is typically possible.

## **2.10. Built features**

While the environmental features of the study area provide the essential backdrop to archaeological formation processes of the area, it is also the canvas on which human actions take place and objects are produced. Furthermore while natural forces



understandably play a large role in archaeological site formation processes, the synergistic effects of human behaviors must also be considered. This and the following sections continue to provide information on the environmental background of the study area, but also provide some essential background to the inhabitants of the area, their material culture, and their land use practices. This section in particular focuses on built architecture and landscape modifications, while the subsequent sections will cover natural and domesticated flora and fauna, and human interactions and practices surrounding them. Particular artifact classes and further specifics will be discussed when relevant in subsequent chapters.

As this study contains the excavation and survey of a number of definite and probable domestic features with evidence for continuity to the present, it is useful to outline some of the important traditional architectural styles seen in the area. Nearly all of any significance are houses, or are otherwise in the same style as a home, excluding Gännäta Maryam Church itself. The simplest of houses is the *tukul* (Figure 2.15). Observing their construction on numerous occasions, *tukuls* at Gännäta Maryam are built by excavating a small, circular ditch. A low wall of fieldstones is then built up from the ditch, supporting a series of wooden posts, usually made today from *Eucalyptus* or *Acacia* poles. These posts then become the foundation for a daub and wattle wall, and a conical thatched roof. While most such *tukuls* are small (~ 5-10 m in diameter), some like main residence of the extended blacksmith-potter family were very large, easily seating a dozen people during our interviews (see Chapter 4), with room to spare. Similar small structures are also built for other purposes, such as housing chickens or sheep, cooking, and crafting, though these usually lack the stone foundation and daub plaster. The abandoned home at Alem Doret surveyed during this project was reportedly a *tukul*.

According to informants, longer established and/or wealthier families frequently live in a structure called a *nas*, a two-storied cylindrical stone house with thatched roof (Figure 2.16). For these structures, stones like vesicular basalt are cemented together with daub to create thick walls. Beams set into the walls support a layer of finer wood and daub producing a second story floor. A stone stair spirals around the exterior to access the top floor, covered by a conical thatched roof. The ground floor is frequently

used for work, storage, and keeping livestock, while the upper floor acts as the primary residential space. The interior diameter of these houses was usually only a little larger than a large *tukul*. A *nas* and associated stone buildings, joined by a stone wall, formed the second abandoned home on Alem Doret.

The third type of house is the modern-styled rectilinear house (Figure 2.17). The construction is similar to a *tukul*, but with a rectangular corrugated metal roof instead of circular thatch. These were most common around the village. They likely take their shape to make best use of the metal sheets, and appear to be a modern adaptation, since square houses and metal roofs are virtually absent in aerial images and other evidence of earlier decades. Dimensions, number of stories (two maximum), and other features such as second story wooden porches were variable, and presumably dictated by the whims and resources of the owners.

Common to all these structures are the use of daub to construct internal spaces. Daub and wattle walls separated sections of the potter's home. Daub or daub and wattle benches, beds, storage spaces and cooking platforms can be found in each type of construction. Many residents live in homesteads, here defined as collections of structures for different purposes, often surrounded by a wall or other property boundary marker. Homesteads are common in the area and typically make use of a number of different architectural types. For example, a primary house might be a *nas*, but *tukuls* might be built nearby for storage, extended family members, or other uses. Similarly, houses like the *nas* home on Alem Doret may have a number of *nas*-type stone structures, or a number of *tukul* structures. Walls or property markers similarly vary, but are quite common, though not universal. Some, like the small *tukul* built in one of the fields during our first field season, are simple fences made by piling acacia brush, sufficient to keep chickens in the yard. Larger or longer-established homesteads often had more substantial walls made of stacked rock, closely spaced plants, or occasionally wood or metal fences.

The other major built features of the landscape are the numerous retention structures that bound fields and stabilize slopes. Most field boundaries are simply packed earth bunds slightly elevated above the surrounding ground surface and often placed relative to the topography such as those seen across much of Tabot Madera and Agay

Midir. In areas of greater topographic relief between two fields however, these bunds may form high, sometimes over a meter, and often producing a lynchet morphology on the slope. Frequently, *Aloe* and other plants are planted along these boundaries to help mitigate the erosive effects of overland flow. In some instances, though far less frequently, such bunds might be built exclusively of or supported with stones, particularly when they bound fields of different heights. Low stone bunds have also become a common feature recently of uncultivated hillsides as part of fairly recent local erosion remediation efforts (see Chapter 3). In cultivated lands on the most extreme topography, bank-and-ditches appear to be becoming more common in recent years. At Kiflie Mado, for example, numerous bank-and-ditch terrace walls have been constructed. The banks are composed of two parallel stone walls filled in with packed earth, while the ditch is excavated on the upslope side of the bank during its construction. Simpler bank and ditch features of loose earth were also observed along some footpaths in steep areas to help control and guide runoff. Numerous other field wall and erosion remediation structures exist in Ethiopia (see Hurni 1986), though no further styles were observed in the study area itself.



Figure 2.15. *Tukul* structures at Gännäta Maryam. Note the stone terrace wall and acacia brush fence around the *tukul*.



Figure 2.16. A *nas* house at Lalibela.



Figure 2.17. Recently built houses with tin roofs at Gännäta Maryam

## 2.11. Local flora and agriculture

As the designation "dry evergreen Afromontane forest and grassland complex" (Friis et al. 2011) implies, the region of Gännäta Maryam and the majority of the adjacent lowlands (which are still within the subtropical zone), is characterized by extensive acacia scrub and semi-arid woody trees, bushes and grasses. Acacia dominates much of the study area and surrounding regions of equal or lower elevation, though other woody tree and shrub species dot uncultivated slopes. Single or stands of *Ficus* and *Juniperus* are common, particularly around Gännäta Maryam village and similar habitation areas where such trees provide shade. In areas not under regular cultivation, such as steep slopes and gullies, grasses and woody perennial scrub dominate, but are gradually infilling with young trees, most of such areas having been deforested earlier in the 20th century (see Chapter 4). At the alpine elevations above the terraces of the study area, *Juniperus* becomes the predominant tree species, while the scrubby dry vegetation

transitions to lower grasses and herbaceous perennials. Throughout both regions, *Aloe* sp. are quite common, as are introduced genera such as *Yucca* and *Opuntia*.

The agricultural crops normally grown in the study area according to local informants are: teff (*Eragrostis tef*), barley (*Hordeum vulgare*), wheat (*Triticum* sp.), sorghum (*Sorghum bicolor*), chickpeas (*Cicer arietinum*), peas (*Pisum sativum*), lentils (*Lens culinaris*), maize (*Zea mays mays*) and a small variety of unidentified beans. Each crop has a preferred soil and planting time. According to local informants, varieties of teff, sorghum, and wheat are the most commonly planted crops, though chickpeas and other legumes are often planted on the Vertisol soils as they tend to fare better than other crops under the soil's unique conditions. Assorted other plants covering numerous fruits, vegetables, and oil seeds are also grown in lesser quantities, usually in home gardens. Plants for utilitarian purposes like live fencing (e.g. *Aloe* sp., *Euphorbiaceae* sp., *Opuntia* sp. - which also produce fruit) and craft production (e.g. *Yucca* sp.) are also common. Eucalyptus, introduced to Ethiopia near the beginning of the 20th century (Horvath 1968), is also commonly grown in large, well-ordered stands. In the study area, such stands were commonly encountered near perennial or quasi-perennial water sources such as spring-fed gullies. Facing a dearth of other suitable tree species, the wood is used for lumber and fuel.

Casual observation of the region, due primarily to trips to other sites and regional surveying in 2009 suggest this pattern of natural and cultivated vegetation is common throughout the region, though with certain exceptions. Prominent historical churches, for example, are often surrounded by much larger and more mature stands of *Juniper* dominated forests, although Gännäta Maryam is in a uniquely rocky setting that precludes this type of growth. Meanwhile, riverine areas like the Takezze headwaters one crosses to reach Gännäta Maryam from Lalibela are under much more intensive cultivation of a wider variety of fruits, vegetables, legumes and grains.

## 2.12. Fauna

Fauna, as they are relevant to this research, are dominated by domesticated species, commensurate with the extensively cultivated and artificially modified environment. These include fat-tailed sheep (*Ovis aries*), western highland goat (*Capra aegagrus hircus*), zebu cattle (*Bos taurus indicus*), chickens (*Gallus gallus domesticus*), dogs (*Canis lupus familiaris*) and to a much lesser extent, donkeys (*Equus africanus asinus*) and horses (*Equus ferus caballus*). Many families in the research area maintain at least a few goats or sheep and chickens. While chickens are rarely permitted beyond the yards of homes, sheep and goats are regularly grazed across different areas of the region depending on season (see Chapter 3). Cattle are essential draft animals for traditional plowing, though are rarely used for meat or milk in rural areas. Informants report that cattle were once more common, though their upkeep for many today is prohibitive, so farmers often rent out their cattle for plowing by other local residents (see Chapter 3). Dogs are quite commonly kept as guardians of property. A few families own donkeys, frequently used for transportation and load-bearing. Only very wealthy or prestigious people such as select priests appear to own horses, and the sight of one is rare, though they were encountered at least once in Gännäta Maryam and a few times on the roads between Gännäta Maryam and Lalibela during holidays and market days.

A survey of wild animals was not made of the study area and such animals appeared rare in any significant volume. Faunal remains and common sense attest that rodents and other small mammals are common (see Chapter 6). Serpents are greatly feared, though appear rare; however, other unidentified reptiles were sighted and appeared in the faunal assemblage. Primates, possibly *Colubus* sp., frequented the hill slopes and were reported a nuisance around homes by some farmers. The infamous gelada baboon (*Theropithecus gelada*) resides in the area, but was only spotted and reported for more elevated and remote areas. Hyena (*Crocuta* sp.) were never directly observed, but on multiple occasions farmers were overheard warning one another about hyena sightings in the area and the need to keep a close eye on livestock. Numerous avian genera and species including hornbills, sunbirds, and finches/waxbills/weavers were observed; the latter considered an agricultural nuisance. Francolin (*Francolinus*

sp.) were not observed, though bones similar to chicken were found among the faunal remains. During previous fieldwork with Catherine D'Andrea (2008) in Tigray, a primary objective of the project was to observe the timing of the introduction of domestic fowl. A problem one graduate student, Helena Zewari, was studying was distinguishing faunal remains of francolin from domestic chicken, the two reportedly being very similar. In and around the study area of Adigrat during that project, francolin were common in the faunal assemblage and still trapped on occasion by residents for food.



## **Chapter 3**

### **Landscape Formation Processes and Research**

#### **At Gännäta Maryam**

*Landscapes are shaped by human action through processes such as clearance, erosion and deposition; they are also the shapers of human action encouraging and constraining various forms of landuse [...]. It is this conjunction of forces which makes it necessary to reconstruct the history of the physical landscape, through studies of past vegetation and geomorphology together with the way in which human groups have patterned their activities across the surface of the earth. (Gosden and Head 1994: 114)*

#### **3.1. Introduction**

The environment of the Ethiopian highlands is as dynamic and unstable as it is beautiful. Expansive and desolate plateaus, perilously steep mountains, and the residents of tiny hamlets eking a living among fields of rock are common sights throughout the highlands. However, such visions belie the true natural state of the highlands as they may have appeared centuries before human occupation and agriculture took their toll. As this dissertation will enumerate, the landscape of Ethiopia has been sculpted by humans as much as by nature, and in turn, nature has conditioned the lifestyles of the people who live in it. While the dramatic landscape of northern Ethiopia has cultivated an

impressively rich cultural heritage, it is these very same natural and human formative processes that have operated ceaselessly toward the erasure of its archaeological heritage. The following chapter introduces the themes of this thesis: how behavioral and natural formation processes have affected the geomorphology of the Gännäta Maryam region producing an archaeological landscape that has been extensively disturbed. Reconnaissance has revealed an archaeological landscape composed primarily of muddled or displaced surface remains, and microenvironments where the confluence of conditions creates the only refugia in which subsurface remains were found preserved intact. The theoretical grounding of this research has been strongly influenced by theories of landscape and behavioral archaeology outlined below. Attention, then was paid to both human land use patterns, geomorphology, and the ongoing interactions between the two as critical components for designing effective research methods (Richards 2008: 553-554) directed to the goal of understanding the formation processes that have been active on archaeological deposits from their moment of deposition to the present. Under the best of circumstances, understanding such practices in turn aids reconstruction of original archaeological contexts, though as Gännäta Maryam demonstrates, such reconstructions at times may be out of reach.

### **3.2. Defining landscape**

In approaching this project, it was first necessary to contextualize the research area within a methodologically useful paradigm. In such a disturbed archaeological terrain, the identification of "sites" and non-sites for isolating research areas was swiftly recognized as a fruitless pursuit to the aim of understanding local history. A broader perspective on the terrain was needed that could account not only for the archaeological units of study, but for the contextual space and time in which those archaeological objects have undergone extensive transformation from their initial depositional contexts. The archaeological concept of "landscape" provides such a conceptual framework for investigating such a broad spatial and temporal study.

Landscape archaeology, to be sure, is a vast umbrella of theoretical and methodological approaches to studying the spatial and temporal relationships among people and place in the past and present, leading some to term it a "usefully ambiguous concept" (Gosden and Lesley 1994). Johnson (2007: 3, citing Rodaway 1994), for example, provides eight different definitions of landscape proposed by different authors. All definitions, however, share a concern both for the physical features and spaces of a place, many often formed or affected by people, and for the perceptions of, and behaviors conditioned by, that place. Early trends in landscape archaeology emphasized the significance of reconstructing past environments in order to better understand the "multiscale" and "multidimensional" aspects of human ecosystems and the relationships between nature, culture, and adaption (e.g. Butzer 1977, 1980, 1982; Renfrew 1976; Gladfelter 1977). More recent approaches have come to appreciate landscape not only in terms of its ecological qualities, but its cognitive perceptions through experience and practice (e.g. Tilly 1997; Bender 1998; Kryder-Reid 1996, 1998; Smith 2003). While both approaches have merit, their explanatory power either falls short of or is unsuited to explaining the formation history of Gännäta Maryam's now piecemeal archaeological record - a formation history which is necessary to understand before further more nuanced interpretations of human ecology or perception can be contemplated.

For this study the most useful notion of landscape is that of a palimpsest, articulated by Crawford (1953) and Bailey (2007). In particular, Bailey's (2007: 204-207) theories of cumulative and spatial palimpsests appears to have the most direct relevance to the problems posed by the research area. Though nuanced, the metaphor of the landscape as palimpsest implies a history of successive inscription and complete or partial erasures. Literal palimpsests are manuscripts that have been written on successively. Each new text required the erasure of the old, though often traces of the old remained. Transferred to landscapes, the metaphor describes the phenomenon of the physical features left on landscapes by human activities and natural processes. Major events and processes each inscribe evidence for their occurrence on the landscape, though future events may obscure the traces of previous events in the creation of their own inscriptions. Thus, a well maintained series of medieval field boundaries belies the

practices of medieval land management, but the centuries of tilling and erosion would nearly have erased all traces of earlier Bronze Age barrows.

The concept of a cumulative palimpsest expresses the idea that with successive episodes of inscription, much of the archaeological evidence may be conflated, diminishing the temporal resolution of the archaeological contexts as the remains of temporally discrete events blend into one apparently continuous deposit. Spatial palimpsests do not necessarily escape the problem of cumulative palimpsests and lost temporal resolution. Rather, spatial palimpsests add a horizontal dimension encompassing the possibility that different spatially discrete activities and localized conditions might thus differentially affect earlier deposits across a defined region, disturbing some while perhaps preserving others, for example.

For Crawford (1953), the idea of a palimpsest landscape implies that the terrain can be metaphorically dissected and read by reconstructing past events and processes from their traces on the landscape, peeling back their interwoven layers, to understand how the archaeological record came to be what it is today, and perhaps to reconstruct how it may have looked in the past. For Bailey (2007), however, the crux of his categorizations of palimpsests is that some information is necessarily lost, particularly in terms of temporal resolution. As palimpsest processes reduce spatial or temporal resolution, so they may thus reduce the precision with which past states can be reconstructed. Geophysical survey, for example, may help identify the presence of the Bronze Age barrows mentioned above, and models can describe how plowing and erosion destroyed them, but information such as the relative date of each barrow's construction and use-life may be irrevocably lost.

### **3.3. Formation processes**

While the landscape as palimpsest provides a suitable conceptual framework for approaching the Gännäta Maryam landscape, it lacks an explicit methodological component for untangling the interwoven and blurred processes that went into making it.

Schiffer's (e.g. 1976, 1987, 1995) theories on formation processes and behavioral archaeology provide such a theoretical and methodological approach.

For Schiffer, a major concern in archaeology should be an understanding of the transition of materials from their "systemic context," the context and conditions under which an object or feature was acquired or produced and used, until and beyond the object became part of the archaeological record. The underlying assumption of this concern is that the provenience of an archaeological object does not necessarily reflect the original locus of the artifact's use (Schiffer 1972: 156, also in 1995: 25). This is due to both human behaviors (c-transform) and natural processes (n-transform) that modify an artifact's spatial position between the moments of use, discard, and current archaeological context (Schiffer 1976). These are collectively the formation processes of the archaeological record that can affect artifacts, contexts, and landscapes in a number of ways (Schiffer 1987). An object may be discarded or moved from the point of its original use to another point based on behavioral processes like floor sweeping, organized trash discard, or recycling. Artifacts may also be retrieved from their archaeological context and reused. Processes like erosion may then disturb the final anthropogenic depositional context. These processes may not only disturb archaeological contexts, but also introduce patterns of their own (Schiffer 1987: 10-11), such as areas of good preservation and areas of complete erasure. A failure to understand how and why formation processes have interacted to create the contemporary archaeological record may lead to erroneous interpretations. Schiffer (1987: 8-9) however, argues that by understanding formation processes, even in badly degraded contexts, some valuable inferences may be extracted from the archaeological record.

Understanding the cultural and natural processes in play at Gännäta Maryam became a crucial component for interpreting as best as possible what has remained, even though in many instances a full picture is impossible to reconstruct. The following sections deal with the theoretical and methodological components of site formation processes as encapsulated by Schiffer's c- and n-transforms and his and others' approaches for interpreting them. The first section will deal with Schiffer's theories of behavioral archaeology, which deal with the human component of archaeological site formation, the contexts of archaeological material deposition, and means for inferring the

behavioral processes that resulted in such contexts. The second section deals with natural processes as well as the intersection between natural processes and anthropogenic affects on landscapes. Schiffer is particularly concerned with the geoarchaeological approach to site formation processes, dedicating a large portion of his 1987 volume to the subject. Though the field predates Schiffer and is a discipline unto itself (1995: 50; see below), as will be made clear, tackling issues of natural landscape (trans)formation processes is critical to understanding contemporary archaeological landscape formation processes as well as interpreting archaeological contexts more broadly.

### **3.4. Behavioral Archaeology**

The majority of Schiffer's "behavioral archaeology" (e.g. 1976, 1987, 1995) addresses the human, or c-transform, component of site formation processes, though n-transformation processes are also of concern (see Schiffer 1987) and can incorporate an anthropogenic element, see below. For Schiffer, cultural formation processes are the study of the chain of interactions between people and artifacts, or people and places that affect behavior and land-use, ultimately resulting in the initial formation or modification of the archaeological record. Schiffer calls this the transition from the "systemic context," the context in which an artifact is procured/produced, used, and ultimately discarded, resulting in the archaeological context.

As Schiffer explores in much of his work on behavioral processes (in particular, 1976: 27-41; 1978), rarely is the movement of an artifact through the systemic context to the archaeological context a smooth and linear one. For example, a simple assumed model might say that the life history of an object transitions from its procurement and/or manufacture, to its use, to its discard into the archaeological context. However, such a simplified view fails to acknowledge other myriad behavioral patterns such as the recycling or reworking of material, post-depositional disturbance by cultural practices, and removal from the archaeological context back into the systemic context. Schiffer summarizes these possible transitional relationships as: systemic to archaeological, systemic to systemic, archaeological to systemic, and archaeological to archaeological

(Schiffer 1976: 27-41). An example of this transition is the recovery and reuse of Olmec jade figurines by later Maya people (Digby 1972; e.g. British Museum jade pectoral: AOA 1929.7-12.1) representing a transition from a systemic to an archaeological context, and back into a systemic and eventually archaeological context again. Such recovery and reuse not only has implications for understanding the object, but also for interpreting both the original Olmec archaeological context and the Maya one. This might be termed scavenging by Schiffer (1976: 34), another ethnoarchaeological example being the collection and reuse of lithic materials recovered from abandoned villages by contemporary Konso hide workers in southwest Ethiopia (Brandt and Weedman 2006). Indirect human behavior such as plowing of an archaeological site, as encountered at Gännäta Maryam, is an example of a transition from one archaeological state to another (Schiffer 1976: 29). The objective of behavioral archaeology is to reconstruct as best as possible this chain of contexts and understand how human behaviors coalesce to produce or modify the archaeological record as it exists for the contemporary archaeologist.

Schiffer's "synthetic model" (1976: 11-26) provides the backbone for interpreting archaeological contexts via an understanding of behavioral processes. Within the synthetic model, it is assumed that many of the behavioral processes resulting in the archaeological record are no longer directly observable. It is then necessary to find correlates that might shed light on past practices and conditions, while stipulating other variables, ideally those with some testable or observable parameters or outcomes. From this point one may take the initial observations of the archaeological record and infer the processes that have occurred prior to and following initial discard up to the present (1976: 12-17).

Schiffer (1995: 69-73) proposes four strategies for deriving inferences to interpret archaeological contexts. These strategies combine variously observing past or present human behaviors with past or present material cultures. Though he argues all four approaches are interdependent (Schiffer 1995: 17) the emphasis on observing present behaviors and material cultures for interpreting archaeological finds falls squarely within the tradition of ethnoarchaeology (Schiffer 1995: 70, citing Oswalt and VanStone 1967) and experimental archaeology (Schiffer 1995, citing Ascher 1961). Both ethnoarchaeology and experimental archaeology are variants of a similar approach to

archaeology which contrives or observes a modern system where variables can be controlled and/or observed for comparison to archaeological contexts and materials. Schiffer (1995: 71) admits this approach has its problems and limitations, particularly in formulating law-like conclusions or explaining long-term change, though historically it has been found useful. For example, Binford (1978) argues in his ethnographic research on Nunamiut food processing that such research, while perhaps not a perfect means of deducing past human behavior, is at least an improvement over previous approaches to faunal remains. Criticism of this approach would undoubtedly entail that drawing parallels between present human behaviors and archaeological patterns in deep time is prone to misleading interpretations due to the foibles of human culture. However, in Binford's example at least, his research was reasonably accurate for his study of sites dating through the previous century. While this author acknowledges the problems of ethnoarchaeology and experimental archaeology for explaining past behaviors from present observations, I will argue later that the landscape formation processes ongoing at Gännäta Maryam are unlikely to preserve many materials through the *longue durée*. Much of the evidence supports fairly recent origins of the material encountered there.

### **3.5. Geoarchaeology and geomorphology**

As implied in the introduction and the section on formation processes, a key component to the formation processes at play at Gännäta Maryam is the geological setting. Different soils, different topographic settings, and different degradational and aggradational forces have each contributed to a dynamic and continually evolving landscape. As Bettis and Mandel (2002: 142) so neatly summarize:



...[the] remains of human occupation pass through a geologic filter to become the archaeological record. The filter consists of geographic and temporal 'media' that produce a complex but patterned record that reflects the cumulative behavior of the pedologic and geomorphic systems. Understanding the nature of the temporal and geographic patterns that the filter has imposed on the archaeological record is the first step in identifying archaeological patterns that reflect human choices.

Such a perspective has led archaeologists to develop the sub-discipline of geoarchaeology, the use of geological methods and interests to answer archaeological questions. Geoarchaeology has usually been applied to issues of dating, environmental reconstruction, or formative processes (Waters 1992: 8-12; see also Renfrew 1976), though all applications share an interest in better understanding archaeological contexts (Butzer 1980). Prior to modern chemical dating techniques, geoarchaeology was concerned largely with strata and sedimentation, helping to produce regional chronologies (e.g. Antevs 1935; Bryan and Ray 1940). Later researchers used geoarchaeology as a means to reconstruct the physical landscape and ecology of an area in order to assess how cultural patterns articulated adaptively (or not) with ecological and geophysical settings, producing what Butzer called "human ecology" (Butzer 1982, e.g. Butzer and Hansen 1968; Gladfelter 1977; Butzer 1977).

The third approach, however, is the one that most closely echoes the concerns of Bettis and Mandel (2002) stated above: reconstructing geomorphological formation processes with the intent of understanding how archaeological landscapes and contexts have changed over time due to the effects of natural forces. This is the equivalent concern of Schiffer's *n*-transforms (1987: 22), in addition to biological and ethological factors, though the latter are of less concern to this project. In essence, geomorphic processes are spatially- and temporally-defined processes that can aid the preservation of or disturb the archaeological record. Such processes are patterned and can be studied and understood, demonstrating how archaeological remains have been selectively preserved, lost, buried, exposed, or modified. Once these post-depositional processes are

understood, a more accurate recreation of the past archaeological landscape *may be* possible by mapping out how features and processes in different parts of the landscape have differentially affected archaeological remains through time. Alternatively, such research may lead to the understanding that some archaeological landscapes have been so extensively altered, a reconstruction of past archaeological contexts may be out of reach.

At the most basic level, an understanding of how geomorphological processes alter landscapes can help determine whether artifacts are *in situ* or not, and why. At a larger scale, it can aid in survey projects which aim to reconstruct land-use and settlement patterns, identifying areas where archaeological surfaces may be exposed at the surface, buried, or erased (Wells 2001: 108), thus determining what survey and research methods are most appropriate to each area. Surface surveying is only effective where past archaeological materials are exposed at or near the surface, while areas with deep colluvial overburden may require coring or test units. Similarly, one can make reasonable arguments about whether an area appearing archaeologically sterile is indeed so, or has been subject to extensive disturbance.

The study of geomorphological processes and conditions as they relate to archaeological reconnaissance has had a productive history in archaeology. Stern's (2008) work in Koobie Fora, for example, reconstructed the physical features of the paleolandscape by examining regional stratigraphy and their relationship to past and ongoing aggradational and degradational processes and features. This in turn provides data on the original landscape contexts of archaeological deposits, which is useful for interpreting the activities that took place. Wells' (2001) report on research in Peru and Crete identifies major geological and geomorphic features of the landscape, reconstructs their formation or transformation in relation to other features, and uses this data to supplement and critique results derived from various archaeological surveying methods. In particular, she notes where the apparent absences of sites in some instances might have been due to human aversion toward past landscape features, while in others the landscape itself may have worked to destroy evidence that sites ever existed there. Head (2008), meanwhile, examined an archaeological landscape in Australia, emphasizing the importance of considering scale in regard to archaeological research and survey in diverse geomorphological contexts. Her survey included both a rock shelter and its

surrounding landscape. The rock shelter was the most visually prominent archaeological "site," while surface surveying of the surrounding sand plane alone might have suggested it was less archaeologically interesting. Counterintuitively, however, the geomorphological processes ongoing around the rock shelter made it unsuitable for long-term preservation of archaeological contexts. The sand plain around the cave, however, was able to preserve a much longer sequence of archaeological deposits, though they were not so dense nor readily visible during surveying. Head makes the point that had geomorphological processes not been considered and only the "site" of the rock shelter studied, rather than its contextual landscape, the more extensive archaeological record of the sand plain may have been overlooked entirely.

What these studies lack, however, is attention to possible anthropogenic affects on landscapes, and in turn, changes in human behavioral patterns in response to changing geomorphic conditions. While natural landscape formation processes are an unavoidable subject in that they are the baseline for all geomorphological processes, the literature is full of examples of humanity's abilities, intentionally or not, to affect landscape change and respond to such changes. Gosden and Webb's (1994) excavations on Papua New Guinea, for example, make an excellent case for the necessity of considering not only the natural geomorphological processes, but also the effects humans may have on such processes. Through their excavation of sediment deposits along the shores of islands off New Guinea's southwestern coast, they show how the construction of Lapita villages affected sedimentation along the shorelines and in turn later settlement and agricultural decisions. Lapita housing on the shorelines appears to be a slightly later development in Lapita settlement of the area. Original settlements are theorized to have been further inland where clearance of the natural forest and farming there accelerated soil erosion to the coast. Eventually, clustered settlements began to appear along the islands' sheltered shores. The housing and refuse disposal of these settlements accumulated sand in their vicinity that would normally have eroded to the level of the rest of the shore. In turn, these sandy elevations acted as dams, holding behind them the fine clay sediments eroding from the interior. Eventually, the clays behind these dams themselves appear to have been viewed as suitable agricultural terrain and a rapid growth of shore-line settlement and agriculture ensued down through generations. Oral history and later

sediments show a change in preference back to the island interior and a new regime of erosion and sedimentation along the coasts. Thus, they conclude, the sediments are both a good indication of cultural activity and proof that the environment responds to human activities as much as the humans may adapt to their environments (Gosden and Webb 1994: 47, 49). In a similar vein, Price et al. (2011) examine the long history of dramatic anthropogenic landscape changes that have occurred in Britain. As successive generations of humans and settlers extracted resources like wood, stone and metal from the landscape, they progressively modified the ecology and topography. In part, this then also affected future settlement patterns as forests were cleared, fields were opened up, and swamps were drained, or created by increasing runoff. This culminated in the most dramatic reshaping of the landscape that came with the Industrial Revolution and large-scale mining efforts.

As a process that occurs over time, however, interpreting some events and processes through observation and measurement is not always sufficient or feasible. Besides basic methods of field geology, other tools are frequently used to supplement the record observed from the ground. Aerial photography (and its modern iterations in satellite imagery and remote sensing) has proved particularly useful in the past and was especially so for this thesis.

The potential benefits of aerial photography for archaeological research were recognized very early in the discipline's history and became a prominent topic of discussion following WWI as exemplified by Reeves' 1936 article in *American Antiquity*. Many early initiatives seemed largely concerned with discovering and mapping archaeological and other landscape features, a utility which has been maintained through the present, even forming the basic prerogatives of groups like the English Heritage Aerial Survey Team (Bewley 2003). However, simple survey and mapping, while useful, is only one of many uses for aerial imagery that has been developed over the past century. Not long after WWII, scholars began to realize the possibilities aerial imagery had for studying not only archaeological subjects themselves, but the effects subsequent natural and human processes have had on the landscape containing the archaeological features, eroding them, burying them, obscuring them with roads and buildings, and otherwise changing their physical structure and appearance (e.g. Crawford 1953). In

short, archaeologists had already begun at an early time to recognize the value of aerial imagery for observing and making sense of natural and behavioral transformation processes in the landscape as they pertained to archaeology.

As Kijowska et al. (2010) argue, the power of time lapsed aerial photography is that each photograph captures a landscape at a singular moment in time. If the landscape is a palimpsest, each photograph is then a "frozen palimpsest" (Kijowska et al. 2010, 156) preserving indefinitely a visual record of "ongoing palimpsest" processes at one discrete moment in time. Because many processes happen at a scale larger than what one person can observe, or have happened prior to observation, Kijowska et al. (2010) argue that studying numerous aerial photographs taken over time opens a way to analyzing the sequence of ongoing palimpsest processes (or Schiffer-ian formation processes, see below) in a medium accessible and comprehensible to the researcher. To prove their point, they study the 20th-century history of a set of Polish towns beginning with initial photographs from the mid 20th century. The photographs represent the frozen palimpsest, to which they add the ongoing palimpsest of the time: the known archaeological and historical features and events of the region up through the period of the photographs' manufacture. Thus they are able to indicate things like medieval field boundaries, historic homes and other temporally separate, but intermingled landscape features. Going forward in time, the aerial photos record the Soviet-sponsored industrialization of the towns, population growth, and modern expansion, exemplified by the expanding brush and eroding field boundaries of industrializing burgeoning urban centers, the expansion of roads, and new housing developments.

### **3.6. Studying formative processes at Gännäta Maryam and interpreting the archaeological record there**

Early fieldwork at Gännäta Maryam revealed that while the area was rich in archaeological material, it lacked significant *in situ* archaeological contexts. Furthermore, archaeological research has not previously been done in this area, and little is known of Post-Aksumite archaeological sites in general, so there was little research to fall back on to make sense of the material recovered from the disturbed deposits. The

theoretical views outlined above provided the framework for making sense of the archaeological record at Gännäta Maryam as best as can be reconstructed at this time. These views and approaches then do not express the original research intentions directed at the study area, but were adopted and adapted as the realities of regional disturbance and ongoing processes were recognized and gradually understood. The following provides a brief outline of theories and methods related to those discussed in the previous section (e.g. landscapes-as-palimpsests, experimental archaeology and ethnography as means of understanding behavioral patterns, and geomorphological research) that have previously been applied to archaeological research in Ethiopia and dovetails the discussion with their relevance to work at Gännäta Maryam.

Throughout the period of fieldwork, a gradual picture of local landscape formation processes began to emerge, illustrated by direct archaeological observation and observation of and discussions with local residents. It became clear that while the area may have been historically important and rich in processes and events sure to leave archaeological traces, later processes and behaviors successively worked to disturb the evidence of earlier events. The preservation of certain pits cut into the bedrock with datable carbon samples at Tarla Terrara (Unit 4), for example, provide evidence for obvious past events; however, more recent forest clearance and plowing almost certainly destroyed any surrounding materials and features that may have provided the pits with much needed contextual information.

The idea of the landscape as palimpsest then, seemed like a logical way of framing a reconstruction of the landscape. For example, a number of large artifact scatters dot the study area. In the region of Tabot Madera, the artifact scatters appear discrete and certain artifacts are uniquely associated with certain scatters. This all suggests the remains represent different contexts. Commensurate with the nature of a cumulative palimpsest, however, it is difficult if not impossible at this time without more information on regional artifact typologies and chronologies to distinguish the different temporal ranges these artifact scatters may represent individually and relative to one another because erosion and plowing has stripped them of any stratigraphic control. The concept of a spatial palimpsest likewise is an apt way of describing how certain terrain and behavioral practices overlap in different combinations to modify the archaeological

record in different ways. While the loss of temporal resolution characteristic of the cumulative palimpsest still applies at Tabot Madera, for example, it is quite likely the sloping vertic soils in some areas have dislocated and dispersed many associated artifact scatters while in fairly level areas of the plain, dispersal is more even and likely reflects more closely the original distribution of deposition (see Chapter 4).

As many of the processes likely to have formed and disturbed the archaeological contexts at Gännäta Maryam are recent or have been ongoing for some time until the present, Behavioral Archaeology's application of ethnoarchaeology and experimental archaeology seems well suited to understanding such processes and contexts. While such an approach may be less appropriate were one to assume that current conditions do not necessarily reflect past ones, it appears likely, as I will argue later, that disruptive processes at Gännäta Maryam have a fairly strong impact on the archaeological record. Over time, they are likely to erase evidence for earlier levels of the palimpsest more completely than recent ones.

The tradition of experimental and ethnoarchaeology in Ethiopia is a rich one that has and may continue to prove very useful for interpreting past actions and behaviors, as well as helping interpret artifacts and archaeological contexts. Arthur's (2002) study of contemporary pottery use alteration among the Gamo of southwest Ethiopia, for example, has shown how traditional beer brewing results in diagnostic attrition marks on the interiors of ceramic vessels caused by the reaction of the ceramic body to the fermenting beer. As beer brewing has traditionally been associated with social status, analysis of archaeological ceramics with an eye for such attrition marks may help not only to identify the function of such sherds, but also model variation in economic status across a study area. Meanwhile, at Aksum, Laurel Phillipson has done extensive work comparing ethnographic and archaeological lithic tools and tool use to archaeological remains. In one instance, for example, Phillipson (2000) reconstructs iconic "Gudit scrapers" and examines the use-wear patterns on the scrapers and their use-marks on various artifact materials including ivory, wood, and stone. She finds that the use-wear closely matches that seen on wood and ivory, thus concluding that the dense concentrations of Gudit scrapers found in discrete contexts may have been part of organized production of goods from those materials. In a similar research experiment, she compares another type of

lithic tool to the marks found on the insides of ceramic vessels, demonstrating that the tool leaves similar marks on the surface of clay and was thus probably used for finishing the interiors of large, coil-built ceramic vessels (Phillipson 2013).

In this project the author and his team conducted surface surveys over the remains of a house where the date of occupation and abandonment were both known (this chapter and Chapter 4). The dispersal of artifacts and other materials from the house were then compared to the dispersal of artifacts found in other surface collections, and considered in context with other local behavioral practices, such as the recycling of material. Thus it was possible to deduce possible interpretations of the formation processes of these scatters by comparison to modern behavioral practices and the known formation processes and life history of a recent archaeological feature. Extensive interviews were also held with local potters (Chapter 6) regarding traditional ceramic manufacturing and, importantly, recent changes to ceramic production practices. These interviews helped to understand some modern and historic land use practices, identify distinguishing characteristics of modern and historic pottery, and identify characteristic signs of certain production practices that had initially been overlooked.

Further interviews were also conducted with local residents regarding their past and ongoing relationships to the surrounding landscape and behavioral patterns related to it and their material culture. The importance of understanding such transitions at Gännäta Maryam was immediately apparent, from the sight of children using old lithic materials for gaming pieces to the many residents who regularly came to us with well-preserved pottery and other artifacts they had recovered around their properties. The results of extensive interviews with local residents describing the cultural formation processes ongoing at present are discussed at length in the following chapter. In many instances these processes directly affect the archaeological record. In others, such as the interviews with the former owner of the recently abandoned home site mentioned above, the processes that went on at this site recently may reasonably be argued to have been common practice in previous centuries as well, at least as far back as the majority of archaeological contexts in the study area. Experimental and ethnoarchaeology then laid some important groundwork for the project, helping to establish possible cultural formation processes and interpretations of the archaeological record.



While behavioral processes, then, were clearly important matters to tackle, it was also necessary to understand geomorphological processes. Rills and gullies, thick layers of alluvium and colluvium, and the obviously distinct nature of different soil and landforms and their affects on archaeological contexts were all of immediate interest even before an awareness of the significance of behavioral processes emerged. A large portion of this research project, then, sought to understand the geomorphological processes at play in Gännäta Maryam, both natural and anthropogenic. The geomorphological study of archaeological sites has a long and productive history in Ethiopia and has frequently put particular emphasis on the human impact on the environment.

Butzer's 1981 paper, for example, links favorable paleoclimatic conditions to growing agricultural intensification at Aksum. Examining the geomorphology of hill slopes and surrounding fields, Butzer concludes this intensification led to severe environmental degradation and eventually rendered the landscape of Aksum incapable of supporting the city agriculturally, leading to its collapse as a major metropolitan center. More recently, French et al. (2007) have challenged Butzer's assertion. Examining local stratigraphy, sediments, and fluvial features, they concluded that the environment around Aksum was likely quite stable during the city's peak, and only began to degrade early in the second millennium as local populations declined. In another study, Ciampalini et al. (2008) used plow scars visible on boulders around Aksum to estimate the rate of soil loss, effectiveness of Aksumite terracing practices, and reconstruct the topography of the Aksumite Period fields relative to today. Bard (1997), similarly, has spearheaded extensive research into the paleoenvironment and human ecology of the Tigray region, Aksum in particular, encompassing a number of different multidisciplinary studies and reconstructions.

In a similar vein to the Aksumite research, environmental and geomorphological data were observed at Gännäta Maryam with an eye toward understanding how natural and anthropogenic factors operate individually and in tandem to produce the past and present landscape, and interpret the affects those processes have on archaeological remains there. For this, the oral histories and ethnographic observations discussed above also targeted how have people have and continue to interact with their landscape, ultimately shaping many ongoing geomorphic processes. While some patterns and

practices have undoubtedly changed over the past few centuries, using oral history and other forms of evidence helps illuminate some changes in behavioral patterns and the reasons behind those changes in ways that a study of geomorphological and the poorly preserved archaeological features of the area alone could not elucidate. This research was supplemented particularly with ethnographic research conducted by Dejene (1990) in the 1980s. Working in the Derg-era Wollo State, which includes the study area, Dejene questioned and observed how land-use practices among local agrarian peasantry changed in response to new government policies in the 1970s and 1980s. These changes in land-use practices in turn affected local ecology and geomorphology, creating a feedback loop of responses from local residents. Interviews and the collection of oral histories conducted for this thesis correlated strongly to Dejene's work and discovered additional changes in land-use patterns that have emerged in the succeeding thirty years.

Other researchers, however, have also attempted similar reconstructions of past environmental and behavioral changes in the highlands, and discovered that memory and oral history may sometimes be a better reflection of popular sentiments than accurate accounts of observed phenomena (e.g. Crummey 1998). Thus other sources of evidence were also sought out for this dissertation. In particular, repeated aerial imagery taken over the span of 50 years was compared with the ethnographic accounts and observations of both Dejene (1990) and ours. These images not only helped to validate or reinforce oral narratives of behavioral and landscape changes and processes, but also provided visual evidence for them. Time-lapsed aerial imagery studies similar to this have already proven useful for understanding ongoing landscape formation processes in Ethiopia (e.g. Tegene 2002; Munro et al. 2008) and because these studies have strong bearing on this thesis, they will be discussed at greater length below in this chapter.

## **Chapter 4**

### **Research Methodology and Fieldwork**

The following chapter is divided into two parts, outlining the research design and fieldwork conducted at Gännäta Maryam. Part I begins with the evolution of the research project starting with an initial site visit in 2009 following on previous examination of the area by other scholars. Fieldwork objectives, methods, and execution are then described for the two field seasons conducted in the study area. Part II describes the results of the various research components, such as artifact patterns observed in the surface collections and the stratigraphy and features in the excavations. Analysis of these findings is further elaborated on in subsequent chapters.

#### **Part I: Research Development and Methods**

##### **4.1. Introduction**

Research at Gännäta Maryam developed through three phases. The first phase was a reconnaissance survey of the area and an analysis of the feasibility of conducting archaeological research in the region. After this preliminary work, we began an initial site assessment and drawing a list of expectations based on my findings and background research. Initial beliefs among myself and others were that the research area might provide valuable insight into the composition and functions of specialized settlement, such as a royal camp or labor camp constructing the church, associated with the early

Solomonic Dynasty. During the first field season, however, expectations of an important historic settlement were dispelled when I observed how poorly preserved the archaeological remains in the area were. With this realization, the project focus shifted to examining formation processes of the local archaeological record as I believe future fieldwork in similar highland settings are likely to encounter similar poorly preserved conditions. Thus, such research may provide a valuable primer for conducting more effective fieldwork in the future. The focus of the research methods and design section of this chapter will emphasize the newly redesigned project, rather than the proposed methods for the research that was abandoned. This chapter concludes with a description of the archaeological fieldwork conducted and the contributions of each fieldwork segment to the initial understanding and perception of formation processes in the study area.

#### **4.2 . Research phase I: Initial site visit and research proposal**

Informal surveying of the region was first carried out in 2009 as part of the *Centre français des études éthiopiennes*'s Lalibela campaign and regional survey after archaeological remains in the area were first noted by Finneran and Tribe (2004). Finneran and Tribe, citing local tradition and the regional and historical contexts, proposed that the area had likely been the location of a royal camp associated with Gännäta Maryam Church. By extension, the church itself, which contains a donor portrait of Emperor Yekuno Amlak cited as the church's founder (Gerster, 1970: 116; Lepage, 1975; Heldman, 1987; Balicka-Witakowska 1998, 2007; Phillipson, 2009: 116-8, 188), was at the very least a royal church (see Derat, 2003) sponsored by the newly emergent Solomonic Dynasty in the late 13th-century.

Initial prospection of the area surrounding Gännäta Maryam Church in 2009 by the author and Finneran again reconfirmed the presence of surface scatters of artifacts across a broad area of the alluvial plain and hills east of town, and on two smaller terraces above the church. While the majority of artifacts were ceramic sherds, and occasional lithics, Kiflie Mado was noted for a large scatter of iron slag. Because of our research

permits, we were not permitted to conduct any excavations during this period; otherwise, the eroded and disturbed nature of the local archaeology may have been apparent immediately, resulting in a different approach to the site from the beginning of fieldwork.

In addition to this cursory surface surveying, we conducted interviews with local residents. In particular, we talked with *Ato* Gubay and his wife *Wayzeru* Tsehaynesh who reiterated the claim that Yekuno Amlak had come to the region during his conquest of the Zagwe Dynasty at Lalibela. Blacksmiths, potters, and such craftspeople had been part of the royal entourage according to their own oral history, and remained in the area under Yekuno Amlak's orders to help provide resources for the church's construction. When asked where Yekuno Amlak and his encampment had been located during his stay, the family indicated the vicinity of Tabot Madera where the majority of surface remains had been identified. As discussed in Chapter 2, subsequent study of the church by Dr. Tania Tribe (personal comm. 2012) then identified other artifacts associated with Yekuno Amlak within the church treasury, such as the biography of the King and the Mamluk Period platter.

#### **4. 3. Research phase II: Research design and implementation**

In light of the royal associations with the area, expectations were that the archaeological remains in the study area, distanced from most current settlement areas, were possibly those of an important medieval site associated with Gännäta Maryam Church. Given the importance of royal churches for elite power at the time, I hypothesized that any such site associated with a royal church might provide valuable insight into issues of medieval power, authority, and economy at the time. If oral history were correct, the site may even have been the remnants of a royal camp; though at the very least, the site could have provided important baseline data on medieval archaeology for the region, which is still largely lacking.

Beginning research without the benefit of archaeological data for the region and the unknown nature of the site or sites in the study area, the research plan I devised was intended to sample different areas of archaeological interest and seek out features and

artifacts that might elucidate the nature of the settlement. A rubric pairing possible site types with particular artifacts and features expected to typify such sites was produced to provide a framework for evaluating the finds (Table 4.1). While excavations would later demonstrate the archaeological remains of the region are unlikely to be those of a single, spatially and temporally contiguous medieval settlement, the rubric does still support the final conclusion discussed later that the finds at Gännäta Maryam are those primarily of domestic sites, albeit more recent in time than anticipated.

Table 4.1. Rubric of potential types of sites expected at Gännäta Maryam and features hypothesized to be associated with such sites, useful for their identification.

	Royal Camp	Domestic Community	Work Camp (for church construction)
Ceramic	Elite: specialty forms like <i>berelle</i> vessels; non-local products brought with camp; unusual or fine decoration or manufacture; Non-Elite/ Mundane: cooking and small storage vessels; likely few vessels not easily transported such as large storage pots	Primarily local wares for mundane use ( <i>mogogo</i> griddles, drinking cups, large storage vessels, cooking vessels); spindle whorls (if not of stone); few imported items	Primarily local wares for support of work groups incl. mundane wares similar to domestic comm.; some specialty vessel forms or pieces showing signs of use in production of pigments for church, lime plaster, and related work; possibly tuyères
Lithics	Some general use cutting tools; possibly hide scrapers in discrete areas	Hide scrapers; sickle lunates; many spent grinding stones; spindle whorls; reduction flakes	Few dom./agricult. tools like sickle lunates or spindle whorls; pos. specialty tools like sharpening stones or mortar/pestles for pigment and lime processing
Floral/ Faunal	Feasting middens, poss. w/ status segregation among cuts; bones from horses and pack animals; non-local remains brought with camp or collected as <i>gult</i> ; ivory	Mostly local grains, few not grown in immediate region; some animal bones, mostly food animals (cattle, sheep/goats, fowl)	Mostly local grains though some regional goods possible; some faunal remains of food animals
Metal	weaponry, armor or clothing fittings from army or elites; fittings for tents and pack animals; specialty metal goods in place of lithics like knives; precious metals	Few: utilitarian obj. probably recycled regularly, e.g. plow tips; pos. hoes and other agricult. or domestic objects.; few items of precious metals	Specialty craft tools: chisels, picks, smithing tools (if smithing was not simultaneously occurring on Sites A and C)
Other	Imported status objects like precious stone or glass beads, glass drinking vessels	Potentially some beads	Likely few luxury or imported wares; limestone and lime processing debris (charcoal and lime) for surfacing of church interior
Features	Bank/ditch features (Hirsch & Poissonnier 2000); briefly used middens; middens of feasting debris (lg. volumes of animal bones, cooking/eating wares, few domestic items like sickle lithics); corrals for pack animals/horses; king's field and main avenue; craft/market areas on periphery, few to no permanent structures	Generally homogeneous domestic sites w/ some domestic special use areas such as cooking or knapping; domestic refuse middens; all demonstrating prolonged regular use; stone walled house foundations likely; small market in town possible or larger external market partly in association with church	Possibly central storage areas for food rations, or tools; specialty craft areas; tool manufacture/ maintenance areas; lime manufacturing features (pits or pyres, charcoal, etc.); middens and other features representing limited occupational duration
Spatial distribution	Artifact distribution discretely segregated among elite, non-elite and special use areas, radiating outward by status	Artifact varieties and dispersal generally homogeneous though reflective of individual domestic economies; likely internally segregated reflecting use areas within home units	General material culture probably equally distributed, esp. food as rations, though evidence for segregation of different craft areas likely, pos. separate from habitation areas

The first step of research at Gännäta Maryam, as proposed and conducted, was the systematic survey of the three terraces by having project members walk linear transects across the terrace peds at approximately 20 meters apart, noting on aerial maps the distribution and primary types of artifacts and features observed on the surface (Figures 4.1-3). Because of obstructions such as walled housing compounds, feral dogs, planted fields, and topographic barriers, transects were often only roughly linear and equally spaced. The wide spacing seemed adequate for identifying areas of significant surface artifacts, leaving the possibility of more tightly controlled surveying for a later time if necessary. Believing that Ethiopian soils on the plateaus would be fairly shallow (as proved generally true), the presence of artifacts on the surface as a result of plowing was taken as a good prior indicator of archaeological contexts beneath the surface (Redman and Watson 1970) and a reason to focus primarily on those areas, initially at least, rather than areas without notable surface materials.

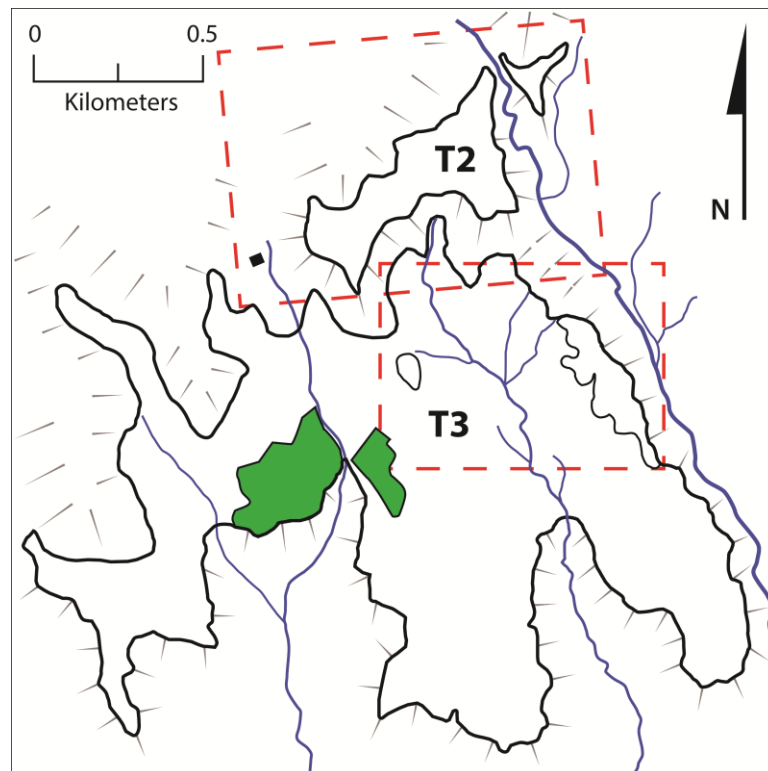


Figure 4.1. The terraces of the study area, T<sub>3</sub> and T<sub>2</sub>. Red boxes identify the areas pictures in Figures 4.2 and 4.3. The green area denotes the modern village and the black square the church of Gännäta Maryam for reference.



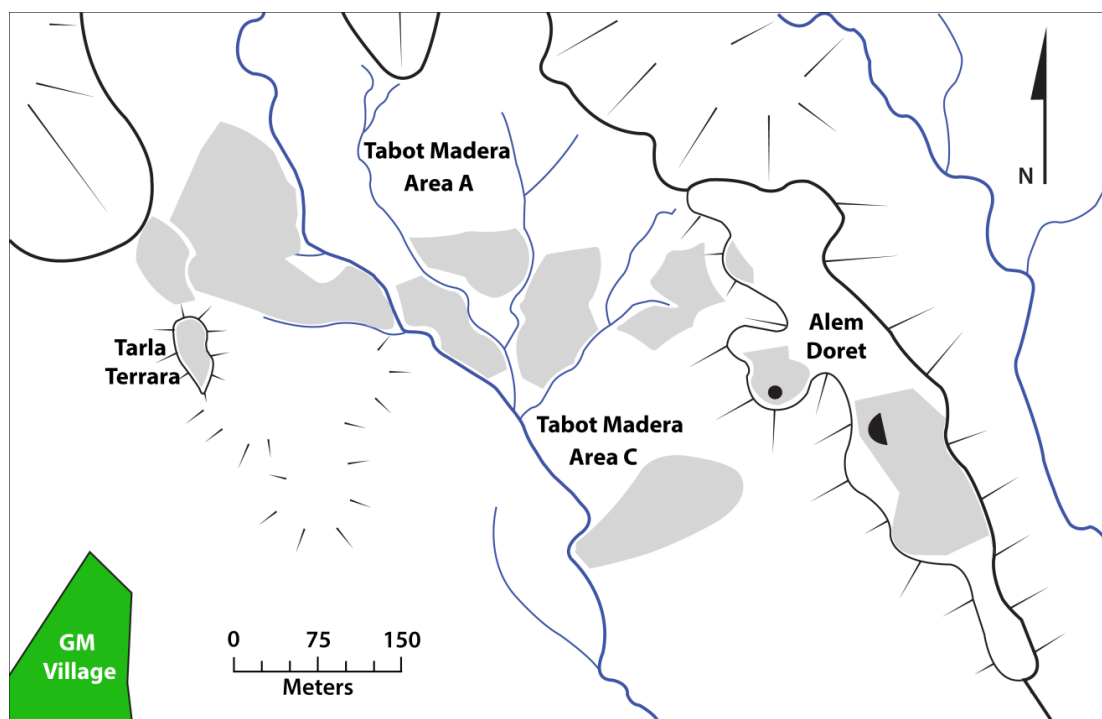


Figure 4.2. Surface artifacts in gray and place names of the lower terraces,  $T_3$ . The conjunction of the wadi and its gullies at the center of the map roughly defines the division between Tabot Madera, Area A (above) and Area C (below). The black circle on Alem Doret represents the traces of the *tukul*, while the crescent represents the abandoned *nas*.

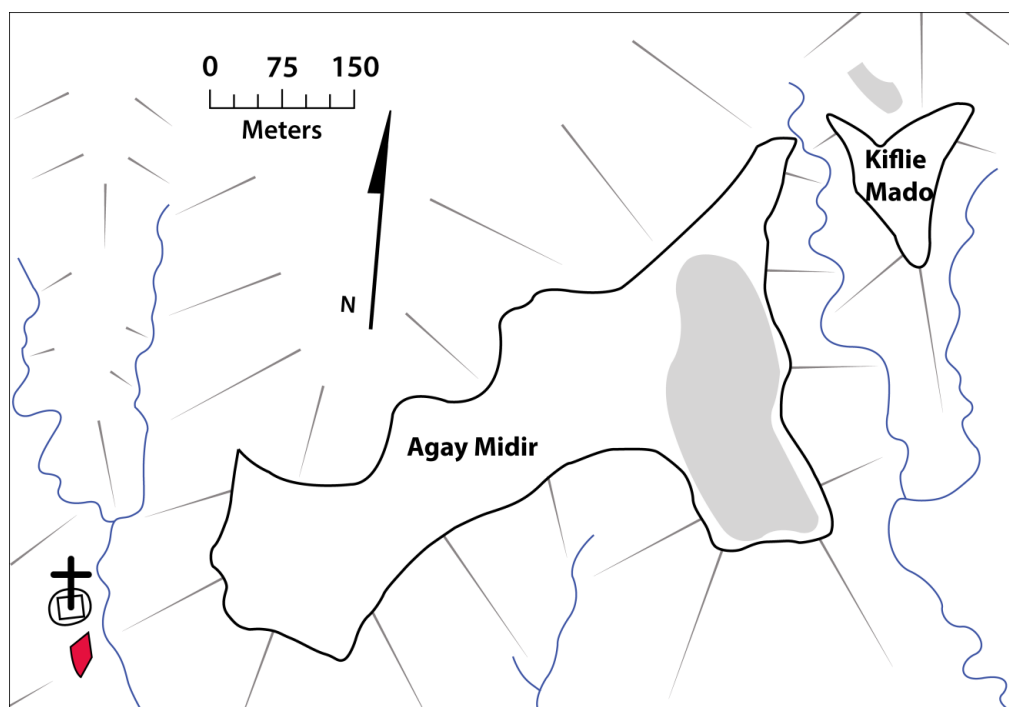


Figure 4.3. Surface artifacts and place names on the two adjacent terraces of  $T_2$  and Gännäta Maryam Church in the ravine to their west, the recently discovered cemetery there illustrated in red.

During planning prior to fieldwork, mapping was to be followed by a systematic series of shovel tests designed to assess the distribution of artifacts and features beneath the plowzone. In turn, this sampling strategy would then provide the guidance for placing excavation units in areas of interest, defined as those that might best address research questions regarding site type and function. However, as the plan was implemented, successive attempts at shovel testing according to the original plan demonstrated that sub-plowzone features were exceedingly rare, and supported a growing realization that formation processes had prevented the preservation of undisturbed archaeological contexts.

Rather than abandon shovel testing altogether, however, I continued shovel testing in a number of locations. The objectives of these additional shovel tests was to understand the relationships between the presence or absence of artifacts and local stratigraphy in the wider topographic and geological landscape, with the goal of building the geomorphological and soil survey discussed in Chapter 2. Shovel test sites were chosen to sample areas representing different combinations of topography, geomorphology, and soils. Selection of shovel test locations, in addition to subsequent work, however, was greatly constrained by the ongoing cultivation of many fields in the research area and the reluctance of land owners to allow us to excavate on recently-planted fields. However, the combination of planned systematic shovel testing and later 'randomly' distributed shovel tests provided valuable insight into the relationships of local geomorphological features and soils, ultimately laying the groundwork for reconstructing the effects of intersecting human and natural formation processes.

My initial shovel tests began in Area A and Area C, comprising the northern and southern areas of Tabot Madera, respectively, where surface artifacts had been found (see Figures 4.1-2 above and Figure 4.11 below). I also excavated systematic shovel tests on Alem Doret. These shovel tests began as a series of transects radiating from a central point in the cardinal directions and at 45° angles from them, with eight shovel tests excavated per transect spaced 15 meters apart. However, as the poorly preserved nature of the local archaeology became apparent, only two radii in two areas were completed. Subsequently, at Alem Doret, shovel tests were oriented along the axis of the hilltop and spaced 25 meters apart. The unsystematic shovel tests targeted at different geological

areas covered the remainder of the research area including further areas of Alem Doret and Tabot Madera, and finally Tarla Terrara.

In general, we excavated shovel tests by natural stratigraphy, or arbitrary levels when strata exceeded about 15 cm. By diameter, they were about 50 cm wide, slightly wider than our shovels. We excavated shovel tests until reaching sterile soil, or until it became physically difficult to dig deeper, usually by about 70 or 80 cm below the surface. All soil was screened through  $\frac{1}{2}$  inch mesh screen; metric unit screens were not readily available. Roughly one liter of soil was sampled from each stratum for possible floatation and  $\frac{1}{3}$  of a liter for potential future analysis.

During this and subsequent stages of fieldwork, we used a manual transit, fiberglass surveyor's tapes, and a GPS to help map the locations of shovel tests and other activities relative to a datum set at the base of an acacia tree near the head of Tabot Madera. Additional datums were placed in various areas such as the hilltops and upper terraces, as it was impractical to measure and sight back to the origin point from these difficult to access and/or obscured locations.

#### **4.4. Research phase III: Surface collections, excavations, and oral histories**

In some instances, it appeared likely that some archaeological features remained intact beneath the plowzone. As such, we opened up a few excavation units as well as conducting extensive surface collections to study spatial and temporal patterns of artifact distribution. While artifact and feature preservation were often poor, my analysis in Chapters 5 and 6 does provide some conclusions about past human behaviors and post-deposition formation processes. The majority of the oral-historical and ethnographic research, discussed below, was also conducted at this phase, particularly during the second field season when the majority of excavations and about half of the surface collections were conducted.

#### 4.4. (a) Surface collections

Surface collections have had a productive history of use in archaeology for meeting relevant objectives such as studying regional culture-histories (e.g. Hole and Heizer 1973; Fagan 1978, cited in Lewarch and O'Brien 1981a), interpreting sites largely destroyed by processes such as erosion and plowing (e.g. King and Miller 1987; Steinberg 1996) and using geomorphological data combined with surface materials to interpret formation processes and thus original artifact contexts (Kirkby and Kirkby 1976; Allen 1991).

At Gännäta Maryam, surface collections served two purposes. Boismier (1991; see also Allen 1991) makes the obvious but perhaps frequently poorly considered point that surface artifact scatters in the plowzone are the result of formation processes. In order to interpret the patterns in plowzone remains, Boismier argues, it is necessary to understand how formation processes may have affected the surface distribution and then design appropriate research and collection methods. Human processes such as plowing are explicit formative processes, but the effects of natural processes such as erosion or colluviation must also be considered. Once the effects of such processes are understood and observed among surface artifacts, it may be possible to step back and understand how the archaeological record has been biased. The primary objective was to use surface artifact distribution at Gännäta Maryam to understand the formation processes that produced them and how these forces affect archaeological patterns with varying conditions. Once such processes were understood, the second objective was to interpret as far as possible the area's human history that produced the archaeological remains.

In general, our surface collections were conducted on a grid with minimum dimensions of 20 by 20 meters, subdivided into two by two meter square collection units. Though more standardized dimensions for grids may have been desirable, topographic features, field boundaries, and the size of artifact scatters often played a role in dictating the dimensions and extent of collection areas, preventing a one-size-fits-all approach. Two by two meter collection units, however, were deemed a suitable size following Lewarch and O'Brien's (1981b: 40) experimentation with surface collection unit sizes where they conclude that 2 m<sup>2</sup> is well suited to identifying patterns in plowzone

distributions. The field crew was tasked with collecting all artifacts visible on the surface within a consistent six-minute time span, generally sufficient to collection all visible artifacts in every collection grid. I made maps and notes of each collection grid and its surrounding environment, noting soil type and texture, the last time the area was plowed, and the presence and location of rills, footpaths, and other surface features. I also used the transit to map elevations at different points on the grid so artifact distributions could be compared to topographic variations in post-fieldwork analysis. Following collection and analysis, information on each collection unit such as artifact size and density, and topographic information within each unit was imported into ArcGIS to produce different types of distribution maps with topographic overlays (see the surface collection discussion below in Part II of this chapter).

Except for the extensive spread of artifacts across the northern half of Tarla Terrara, most artifact scatters were spatially rather small and circumscribed by natural features like gullies or steep slopes. However, in some instances, such as surface collection I (Figures 4.33 and 4.50-51 below), active plowing and planting of the field prevented us from extending our collection area as far as we wished. In most other instances such as Tarla Terrara, Alem Doret, and Kiflie Mado, a single collection grid roughly aligned to the shape and size of the artifact scatters was established.

The methods outlined above were most appropriate for the area and other methods such as screening plowzone soil were not estimated to add additional information. Given that the objective was to compare artifact distributions at the scale of the study area rather than in single areas, collection grids distributed across the study area were preferable to more intensive if not complete sampling of single artifact distributions like the hilltop of Tarla Terrara. Researchers like Steinberg (1996) have made effective use of sieving plowzone material rather than surface collections. Indeed, other researchers have observed "the size effect" of vertical distribution whereby larger artifacts appear to disproportionately collect at the surface of plowzone soil (e.g. Lewarch 1979; Lewarch and O'Brien 1981; Clark and Shofield 1991). However, casual observation of artifact retrieval from shovel tests appeared to show that most artifacts were at or very near the surface, and as larger artifacts are more suited to analysis in this study, the collection of smaller artifacts like small ceramic sherds was not necessary. Researchers like Brooks

(2008) and Boismier (1991) likewise demonstrated the utility of screening plowzone soil sampled from separate randomly or systematically spaced units rather than from numerous contiguous collection units. However, shovel testing at Gännäta Maryam had also shown that despite surface appearances, artifact recovery in screened shovel test soil was remarkably low and thus Brooks' and Boismier's methods may have resulted in low artifact recovery. Furthermore, such a method would have complicated understanding how artifact distribution related to topography and geomorphology at such a relatively small scale as the research area. Hence screening the often rocky soil in the study area, at least where surface material was reasonably dense, would have required additional time and effort with no clear benefit to the research goals. In future research, however, screening may be an excellent method for surveying known, heavily disturbed sites where artifact density is very low on average and maximized recovery of material is desirable.

The Alem Doret *tukul* site, the former residence of Setegen Demele (see Part II of this chapter below), was subjected to a surface collection for comparison to the findings of the other surface collections. With a known history and site description beginning with initial occupation, through abandonment, and to the present (see below), surface collection of the site provided a control for comparison of the artifact distributions of the other sites and provides a comparative sample of artifacts of known date, albeit quite recent. Survey of the site can assist in interpreting how 30 years of plowing may have affected artifact distribution, though original artifact patterning is not certain. The site also provides a sample of wares presumed common to a domestic setting, and the possible archaeological signatures of a *tukul* home, along with oral history about the reuse of materials from the home. The Alem Doret *tukul* site was seen as the best available case study for observing the effects of formation processes in the region, and thus an invaluable site for comparison to the other artifact distributions.

#### **4.4. (b) Oral history, ethnoarchaeology and aerial photography**

Oral history and ethnography have long played a complementary role to archaeological and historical research in Africa toward the reconstruction of the past (e.g. Vansina 1990, Schmidt 1997, Stahl 2001). Whereas many such researchers, however, have desired to syncretize oral history with archaeological data, or explore the contradictions between the two, the objective here has been to supplement the study of geomorphological processes in the study area where they could not be observed directly during the period of fieldwork, and to understand traditional and contemporary behavioral patterns and factors that influence them. Topics explored included things such as observations of erosion and mitigation, historical changes to settlement and land-use patterns, practices around the use of different land features like vertic soils compared to cambic soils and hills verses the flat terrace treads. Such questioning and observations of local practices provide insight into the processes, both natural and human, that have likely contributed to the formation of the current archaeological context in the region such as the history of deforestation and resulting increase in erosion and the contextual chain of artifacts through or between their systemic and archaeological contexts.

As mentioned in the previous chapter, Dejene (1990) provides invaluable supplementation and confirmation of much of the subject matter covered in these interviews. Working in the mid-1980s, Dejene conducted extensive ethnographic research on local people in what was then Wollo State, now divided into North and South Wollo Regional States, the latter containing the study area. While Dejene was not interested in archaeology or long-past patterns and practices, he was interested in many of the same behavioral patterns and responses to recent historical events that are of interest here. In particular, he was investigating how recent events like droughts and the land and development policies of the Derg government affected traditional behavioral practices of the agrarian population. In turn, he compares these practices to environmental data, describing how things like changes in cattle pasturing exacerbate slope erosion and how land policies resulting in greater demand for arable land increases deforestation and reduces fallowing. Dejene's research then provides a useful point of comparison and supplement for the ethnographic and oral-history research conducted here. That the

results of both compare so favorably reinforces the veracity of the information gathered at Gännäta Maryam. Furthermore, it supports the proposition that this thesis can provide a model for assessing transformative processes at similar archaeological sites in Ethiopia beyond Gännäta Maryam because it demonstrates that behavioral processes documented in the study area are representative of the wider region.

With assistance, I conducted formal and informal interviews with numerous residents of the area. Formal interviews were conducted with the community of priests in charge of managing Gännäta Maryam church. Though participation in such meetings often changed each session by the availability of different members, meetings frequently contained half a dozen or more priests and deacons ranging in age from senior clergy to young adults. Formal interviews were also conducted on a number of occasions with members of the extended blacksmith/potter family mentioned previously. Ababu Gubay, the patriarch is a life-long resident of Gännäta Maryam while his wife Tsehaynesh Tshager moved to the area from Mai Maryam, a village a few kilometers west of the historic church of Bilbala Cherkos. *Ato* Gubay provided valuable historical and economic information about the area regarding the nature of craft production and the relationship of craftsmen to the landscape, emphasizing in particular how things had changed for craftsmen following the dissolution of the feudal system of patronage following the 1974 coup. His wife, likewise shared similar insights, but having grown up outside of Gännäta Maryam, was able to provide a more regional perspective. Both individuals and their families were eager to answer questions and discuss local matters.

We also conducted formal interviews with *Ato* Dejene and Setegen Demele. Dejene is a life-long resident of Gännäta Maryam and father of one of our local crew members, Tringo Dejene. Demele is a former resident of Alem Doret, the remains of whose home we surveyed (surface collection L). Both provided invaluable insight into local agricultural practices and changes to such, plus observations about environmental change and social dynamics in the community. *Ato* Demele in particular provided useful background information on his former homestead and the surrounding conditions of the area at the time he lived there, which was useful for drawing inferences from the survey of the site. Questions in the field and during post-fieldwork were also directed to the



office of the local *kebele* administrator, Mulugeta Abegaz, regarding broader matters such as local census and population data and the dates of historical developments.

Informal interviews and questions were directed to a number of additional residents on an opportunistic basis. Frequently farmers and other residents would come to us while we worked and we used such opportunities to gather additional information on locally relevant matters and to reaffirm information gathered from elsewhere. My field crew composed of young-adult residents, in particular Tringo Dejene, and the brothers Yohannes and Wondacha Kassa, also provided frequent insights into local behaviors and assisted in gathering information from other residents.

Reconstructions of past and present environmental conditions and practices were supplemented with aerial imagery of the research area spanning the past 50 years. As "frozen palimpsests" these images help to confirm local recollection of events and changing behavioral and landscape patterns as well as providing objective and measurable evidence for these patterns at given points in time. Insights provided by the photographs not so easily quantified from oral histories and ethnography include things like morphological changes in drainage channels, particularly the wadi, changing settlement patterns, and changes in vegetation cover. While residents mostly all had things to say about these subjects, visual imagery provides a level of detail and confirmed temporal markers that can be compared from image to image up to the present.

Aerial images of the study area were acquired from the Ethiopian Mapping Authority. Each image is at a scale of 1:25 and date from 17 February, 1965 (Serial number 63-157, #14288), and 23 January, 1982 (Series ET 2, S 10, #0270). For modern satellite imagery I used Bing Maps (Microsoft Corp., 2010). Bing Maps are mosaics of different satellite passes and dates for individual images segments are not readily available. However, based on visible landscape features and dates for known events in the region, the image which covers the majority of our research area must have been taken after early 2005 when construction of the most recent school building in the village was complete and prior to March of 2012, when our second period of fieldwork observed homes and other structures not present in the imagery. All images, and all other spatial data were imported into *ArcMap* (ESRI, version 10.2, 2013) and rectified for spatial analysis and comparison.

Use of aerial images, historic photographs and other "frozen palimpsest" images for studying environmental and landscape changes in Ethiopia has a robust history of theory and practice (e.g. Crummey 1998; Kebrom and Hedlund 2000; Tegene 2002; Munro, et al. 2008; Nyssen, Haile, et al. 2009; Frankl, et al. 2011; Shiferaw 2011; Meire et al. 2013). Many of these projects, however, have used surface-based photographs from previous decades for comparison with identically placed contemporary vistas. Tegene (2002), Shirafew (2011), and Meire et al. (2013) were the only two to use primarily aerial and satellite imagery. Regardless of precise means and methods, however, all were fruitfully able to evaluate changes to things like (de)forestation and groundcover (e.g. Crummey 1998; Kebrom and Hedlund 2000; Tegene 2002; Nyssen, Haile, et al. 2009; Shiferaw 2011; Meire 2013), and erosion features like gullies (Munro, et al. 2008; Frankl 2011). Notably, the work of Munro, et al. (2008) and Tegene (2002) used photographs with an average time lapse of about 30 years, while the images used here spanned roughly 20 year increments. This thesis is the only one to use three sets of aerial images over time, while also incorporating oral history and ground-truthing. The study area in this thesis, however, is admittedly very small compared to the others who used aerial and satellite images.

#### **4.4. (c) Excavations**

Our final work on-site at Gännäta Maryam was the excavation of a number of small units and one-by-one meter test units in archaeologically promising areas (Figures 4.17-20 below). One test unit was excavated on the northern half of Alem Doret where shovel testing had uncovered a possible wall feature (Unit 1). Two excavations were completed on Tarla Terrara (Units 4 and 5) following the lead of *Ato* Dejene, who described his discovery of large pit features near the hilltop's margin. Three test units were also excavated at Kiflie Mado: the first (Unit 6) was on an eroding feature of ash and debris over the ground surface to the west of the field of slag; unit 7 was in the middle of the slag field; and unit 8 was behind a wall, resulting in the discovery of a hearth suggesting the area had been a domestic space.

We also excavated two profiles into the eastern wall of the wadi at Tabot Madera and a tall field boundary terrace wall near the shovel tests in southeastern Tabot Madera (Units 2 and 3, respectively). The purpose of these was to examine the stratigraphic profile and determine if *in situ* archaeological materials or features might exist, rather than undertaking the more labor-intensive project of excavating vertically into the fields. If archaeological material or contexts were found, I hoped they may provide chronological information and lead to further excavations in the area. Though they were termed profiles, then, their function was not significantly different from test units and they were recorded using the same data sheets for simplicity.

I and my field crew also assisted with excavations at a recently rediscovered cemetery adjacent to Gännäta Maryam Church in collaboration with the larger Solomonic-Zagwe Encounter Project members. During expansion of the track leading up to the Church, the church community encountered a number of forgotten graves deposited on the steep slope descending from the Church forecourt toward the gully. The slope had already been profiled into three successive terraces ignoring the presence of the graves prior to our arrival, providing an excellent profile of the slope and its contents. Excavations at the different levels of the slope provided an opportunity to examine and measure possible formation processes such as colluviation along the slope. However, analysis of the osteological remains and other artifacts remained the proprietary research material of other Solomonic-Zagwe Encounters Project members.

Recording systems, data points, and nomenclature were based on recommendations of the Museum of London Archaeological Site Manual (1994) for ready comprehension by other scholars and to remain consistent with anticipated practices of other project members. A single context recording system was employed and all excavations followed natural stratigraphy as best as possible. All soil was screened through  $\frac{1}{2}$  inch steel mesh, except for features, which were screened through  $\frac{1}{4}$  inch mesh.

## **Part II: Field Results**

### **4.5. Introduction**

The following is a description of each field work unit and a discussion of the information about local behavioral and formation processes gleaned from that work and the oral history and ethnoarchaeology research. Particular attention is given to the relationship between archaeological remains, their surrounding geomorphology, and known behavioral processes, with preliminary consideration of how archaeological and geomorphological contexts may be interacting. The following chapter, Chapter 5, will elaborate on formation processes substantiated by previous geomorphological research for a concrete assessment of regional scale and context-specific formation processes. Though the majority of oral historical and ethnographic research was conducted following shovel testing, it will be discussed first as it provides useful contextual information about the landscape and ongoing processes throughout the past century. Due to the wide and varied subject matter covered in the local history and ethnography section, it is subdivided into three parts: 1) landscape changes as recounted by residents, other researchers, and aerial imagery, 2) behavioral practices related to material culture, and 3) behavioral practices related to subsistence and land use.

### **4.6. Oral History and ethnography**

#### **4.6. (a) Oral history and ethnography: landscape changes at Gännätä Maryam in the 20<sup>th</sup> and 21<sup>st</sup> centuries**

The landowners of Tarla Terrara and Alem Doret, *Ato* Dejene and Setegen Demele respectively, in addition to numerous other older residents, recounted how the hills and steeply sloping scarps around Gännätä Maryam were once more extensively wooded than today, and it was their belief that generally the entire countryside has largely been deforested well beyond its natural state. Mesfin (1993) and Sebsebe (1998) reported similar local beliefs in the region of South Wollo, the administrative zone just

south of Gännäta Maryam, while conducting ecological studies there. This perception is in keeping with historical and scholarly accounts of Ethiopia's deforestation. Chojnaki (1963) and Pankhurst (1995), for example, have both compiled numerous first-hand accounts of travelers through Ethiopia's countryside spanning the past 500 years. In these accounts, travelers marvel at the barrenness of the countryside, but make important comparisons to places like Gondar, which they claim possessed lush expanses of flowering and fruiting trees in the wealthier quarters, or the territories of church and monastic compounds, where wood is protected and frequently only taken for church repairs (Finneran 2003; Cardelus et al. 2013). To the latter point, one may observe today the lush expanses of grass and woodland around places like Gännäta Maryam, and nearby churches such as Yemrehanna Krestos, among many others (Figures 4.4-5)



Figure 4.4. Protected vegetation around Gännäta Maryam Church, April 22, 2013: Grasses, *Euphorbia*, non-native *Oppuntia*, *Acacia* and other plants. Larger tree species are extant higher up the ravine out of the frame.





Figure 4.5. Clearing in protected native forest of *Juniperus* and other tree species surrounding Yemrehanna Krestos Church, May 17, 2009.

Darbyshire et al. (2003) have analyzed sediment cores from Lake Hayq, South Wollo, about 95 km to the southeast of the study area and within the same subtropical elevation and Afromontane eco-zone. Their analysis shows episodic periods of forests giving way to grasslands, and vice versa over the past two thousand years. Notably, during the first millennium AD, the region's forests gave way to grassland vegetation, presumably as a result of increased intensification of agriculture under a growing population and favorable climate. This is supported by Bard, et al.'s (2001) palynology research at Aksum and other related work (e.g. Bard et al. 2000; Marshall 2009, 2011). This favorable period was followed by further growth in grassland vegetation in the 10th-through 14th-centuries, when the power of Aksum shifts to the Wollo and Amhara regions. After this, forest regeneration of native *Juniperus* and other species grows until the 18th-century, though Darbyshire, et al (2003: 544) posit this return may have been spotty and localized, as historical accounts from this period repeatedly describe this region as treeless and intensively cultivated. Following the 18th-century, finally, tree

species decline in the pollen record precipitously, while the current ecosystem of grass and bush-land emerges (see also Bard et al. 2000, 2001 for comparison and supporting analysis).

Confirmation of this pattern using aerial photos is challenging, as they are grainy and the 1965 photo has poor contrast. However, looking just beyond the terraces of the study area, patterns of change in the vegetation become subtly more apparent. It appears vegetation declines or remains the same across most areas from 1965 to 1982, and then expands again between 1982 to the present. This is particularly noticeable on hill slopes, gully margins, and around settlements and infrastructure. As one resident recounted, it was during the mid-1980s that government officials came to the area and began explaining to farmers how deforestation was negatively affecting agriculture. According to the *kebele* administrator, Mulugeta Abegaz, government sponsored agricultural experts came to Gännäta Maryam and surrounding regions beginning in 1984 and encouraged residents to plant and protect trees. This grew out of an earlier initiative begun in 1981 to reduce grazing on hillsides and protect them from clearance or overharvesting (Crummey 1998: 28 citing Woien 1995a; see also Dejene 35-46, 64-66). It is no surprise then that between the 1982 image and modern images, there is also a very perceptible increase in cultivated non-agricultural vegetation around domestic sites, such as live fences, and an increase in vegetation around some gullies near homes (Figures 4.6-7). Notably the cleft formed by the wadi of Tabot Madera as it leaves the terrace also gains a great deal of vegetation where once there was farmland, perhaps in response to Derg initiatives in the area (Figure 4.7).

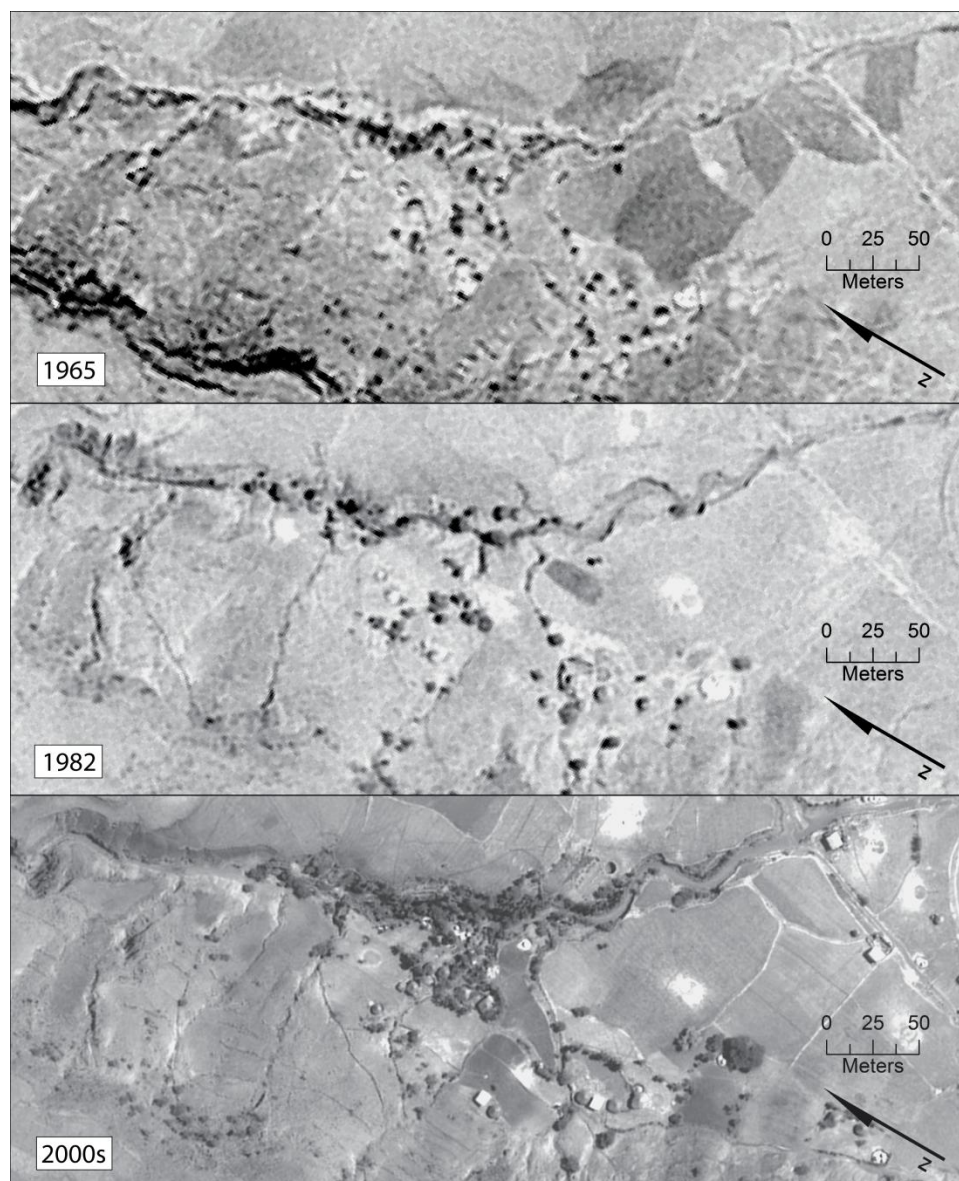


Figure 4.6. Vegetation expansion and growth along a gully west of Gännäta Maryam Village



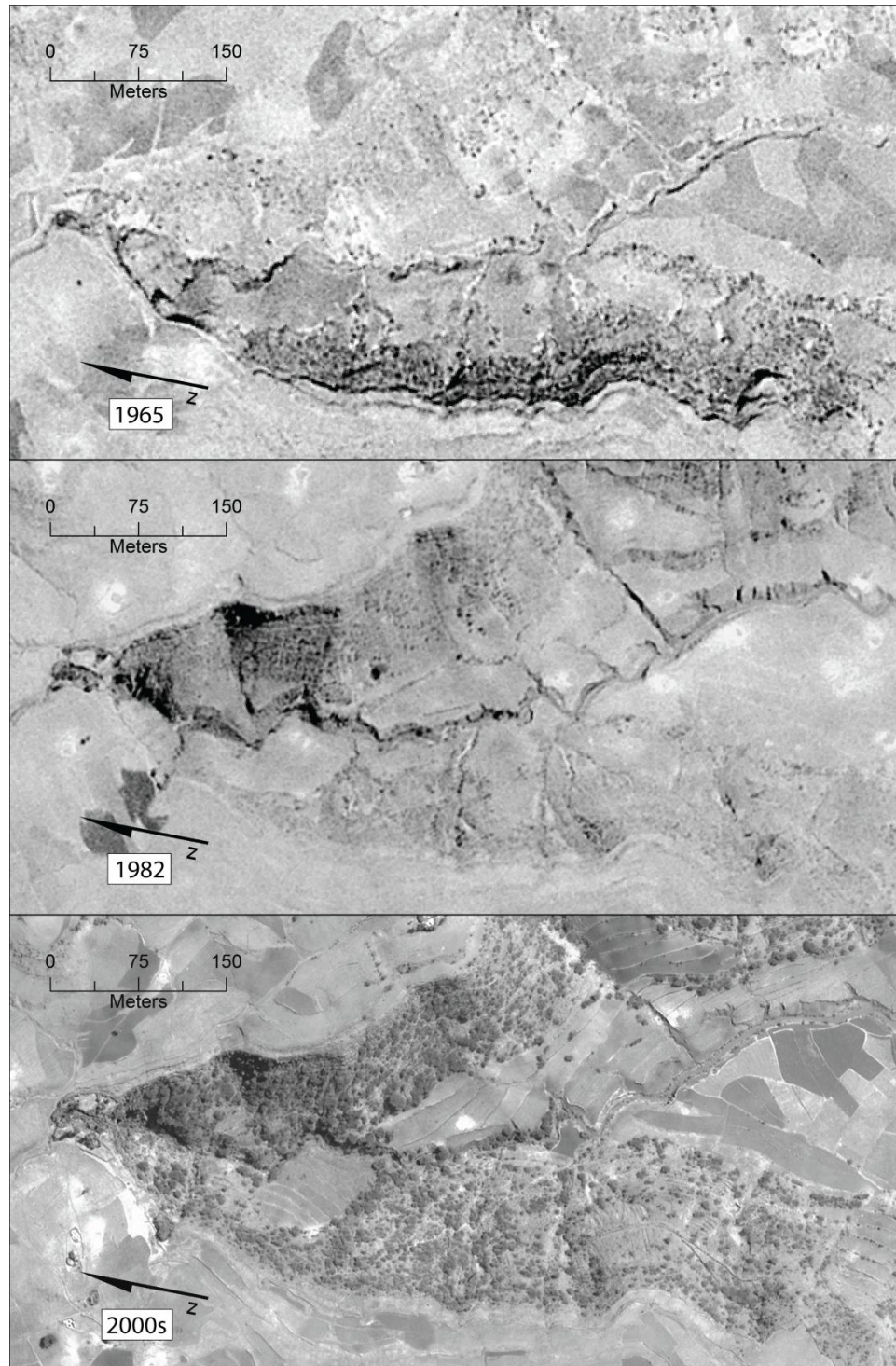


Figure 4.7. Vegetation growth along the scarp descending from Tabot Madera. Note that some former farmland has been allowed to grow wild again. Presumably this is due to hillside enclosure.

A significant shortcoming of this data, however, is that the aerial images are inadequate for determining what kind of vegetation has returned or diminished. While it

is possible in some instances to see singular points of vegetation expand through the images, indicating they are likely trees or other large woody perennials, in many instances denser areas of vegetation only appear as grey and green patches distinct from the surrounding hues. Both Shiferaw (2011) and Tegene (2002) in their analyses of land-cover over time, show that the decrease in wild vegetation cover in Wollo prior to the 1980s was largely a loss of woody perennials (trees and shrubs). From the mid-1980s onward, wild shrubs were maintained in some areas and declined in other, while grassland expanded in all affected areas. Trees did not appear to make a significant return in wild areas. Woien (1995a, 1995b) and Crummey (1998), also working in northern Ethiopia, though outside North and South Wollo, also perceived a decline in some areas in wild woody vegetation. However, they show an increase in concentrated vegetation under intentional human cultivation. This trend appears to agree with our observations stated above. They observed primarily an increase in live fencing and shade or fruiting trees around homes, roads, and other easily accessible areas, and the cultivation of stands of economically beneficial trees like eucalyptus.

Not all areas experienced such a rise in groundcover, however. According to *Ato* Dejene and *Ato* Demele, hills like Tarla Terrara and Alem Doret were not previously considered suitable for agriculture because such hills are considered too rocky and infertile. Instead, they were used for grazing, the collection of woodland resources like firewood, and occasionally for domestic settlement. Throughout the last century, however, residents perceived a growing demand for land based on growing population size and changing social and economic policy (personal interviews and Dejene 1990: 30-35). Interviewees were all vocal about the Derg's land socialization and peasant association initiatives in the 1970s and 1980s discussed below. For families like the blacksmith/potter family at Gännäta Maryam, these reforms meant they were given farmland when traditionally their caste had rarely practiced agriculture or possessed land of their own. Meanwhile, what large landholdings there may have been, such as those controlled by the Church, were broken up and redistributed. Additionally, residents claimed, with improvements in healthcare and education across the region, more children reached adulthood and expected to receive their division of the family land. As these pressures fueled the need for more land, hills like Tarla Terrara and Alem Doret were

cleared and cultivated as a last resort to satisfy local needs, despite their substandard soils. Another farmer added that declining soil fertility in traditionally cultivated areas also pushed farmers to expand their fields up the scree slopes and other marginal areas.

The clearance of Tarla Terrara is visible in the aerial images though the expansion of fields is not. On this latter point, it is possible that the push into marginal areas like Alem Doret and the now reforested cleft of Tabot Madera (Figure 4.7) occurred and peaked prior 1965. However, despite the reapportionment of fields throughout this period, visible field boundaries have remained remarkably stable. These boundaries are frequently small earth and stone bunds or, on terraced fields, large earth risers, all often used as footpaths. Residents claim these features are regularly maintained and are not traditionally modified. Recent divisions they claim are often done with smaller, more ephemeral demarcations, which may not be visible from aerial photos, and can be shifted according to the needs of residents agreed upon by the local Peasants' Association.

Despite expectations of lengthening or widening erosion gullies over time due to minimal groundcover (e.g. Nyssen et al. 2006, 2008; Frankl et al. 2011), visual evidence for these processes in the aerial photos is not clear. Quite possibly the images lack the clarity necessary to see small variations in landscape features, or perhaps the region has been degraded long enough that many erosion gullies have already begun to reach a state of equilibrium with their environment. In a recent paper, however, Frankl et al. (2015) argue that prior to the 1960s, gullies visible in historical photographs from the late 19th and early to mid-20th-century are significantly different from those in more recent times. The gullies had softer edges and were heavily vegetated, suggesting they formed under a previous period of environmental degradation, and had since become inactive relics of that period (Frankl et al. 2015: 195). During the 1960s through 1990s, however, drought, famine, and population pressure put increasing strain on the environment, leading to unstable conditions suitable to the formation or reactivation of gullies. It was during this period, the authors argue, that most active gully networks visible in northern Ethiopia today likely formed. Following the 1990s, environmental remediation efforts begun in the 1980s were continued and began to show fruit. It was during the most recent past that the environment again has begun to recover and these past gullies are again beginning to go dormant or fill back in (Frankl et al. 2015: 196, citing Frankl et al. 2013). Thus is it

entirely possible that much of the gullies feeding the main wadi and other erosion features in the landscape seen in the historical aerial images were roughly contemporary developments that have persisted through to today. Without older aerial images, the discovery of historical photographs and further local interviews may be the only reasonable means to assess the age and development of the study area's gully networks.

While changes in gully morphology may not be visible in the aerial images, the meandering of the wadi and the disappearance of rills with modern remediation efforts are more clearly represented. Comparison of the 1982 and 21st-century aerial images of the wadi in the alluvial plain, for example, reveal numerous changes to the course of the wadi's margins (Figure 4.8). Tringo Dejene showed us by demonstrating with her hands at a meander in the wadi near her property that particularly heavy seasonal rains can erode the cut banks by an estimated 30 cm. In response, some farmers report they shore up their cut banks with stones to protect their fields, while others claimed they similarly shield point bars to increase their arable land.

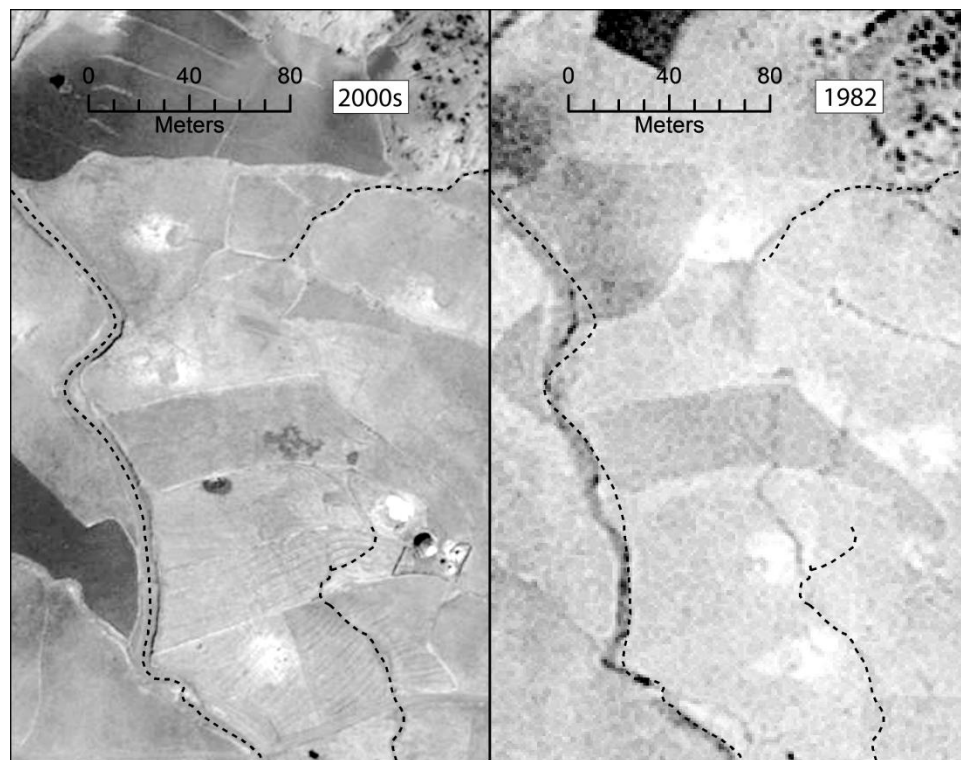


Figure 4.8. Meandering of the main wadi running through Tabot Madera. Note the smooth curve to the center left visible in the 21st century (between 2005 and 2012) (left) and the more sinuous pattern photographed in 1982 (right). Rills present in the floodplain (right of images) also diminish, though have not disappeared entirely.

Also visible in the 1982 photo are a number of rills across areas of the alluvial plain no longer visible today, in aerial imagery, or in person (Figure 4.8). In the modern satellite imagery, a small rill runs through a few fields before dissipating among fields where farmers have plowed furrows perpendicular to their slope. In the 1982 photo, the rill stands out strongly against the surrounding fields and runs up-slope through at least two additional fields. While erosion across the alluvial plain may not be so evident today, then, it was certainly prevalent in the past and has since been subjected to remediation efforts by farmers. In this case, the farmer had been plowing deep furrows into his fields prior to the rainy season in preparation for planting perpendicular to the slope, encouraging runoff to spread across the field, rather than cut through it. The planting of aloes and less commonly other plants was also observed on many field boundaries to help stabilize them, and farmers were observed on occasion collecting wild aloes for transplanting to this end.

The most recent changes to the Gännätä Maryam region have been the government sponsored "food-for-work" programs. Under these programs, the local *kebele* administration has been employing residents to, among other projects, help remediate environmental problems through things like tree planting on slopes and the construction of lynchets and comparatively larger bank-and-ditches. In exchange for their labor, residents receive compensation in the form of seed or food aid. Such programs began in Ethiopia following the 1980s famines, and became more commonplace in the 1990s following the establishment of the current government (Holt 1983; Webb and Kumar 1995; Humphrey 1999). However, the local *kebele* administrator claims the program was only introduced to Gännätä Maryam in 2004 or 2005. Throughout our fieldwork, residents have been building low rock bunds along steeply sloping lands and shoring up the heads and intermediate areas of erosion gullies to prevent their further expansion or down-cutting. In many of these areas, trees and scrub have been allowed to re-grow or have been intentionally planted behind artificial terraces. Residents are forbidden from grazing livestock on these planted areas or killing the vegetation. Some farmers have also recently begun building large bank-and-ditch features around their own fields on steeply sloping lands. Within our research area, these

activities have greatly disturbed archaeological deposits at Kiflie Mado (Figure 4.9), such as bisecting the ash midden at Kiflie Mado (Figure 4.27).



Figure 4.9. Habtamu Tesfaye walks along a recently constructed rock and earth bund at Kiflie Mado. The field in the left corner is the eastern end of surface collection O, the slag site. Note the rock and aloe bund to the right.

It is also worth noting the recent changes in settlement patterns in the area, and considering how this may have resulted in or affected the presence of archaeological deposits in the area. Settlement patterns in the study area have changed significantly as people moved away from the dispersed hamlet model that was reportedly the norm, to the more centralized village model seen in the growth of Gännäta Maryam town. Many residents of the town today, like *Ato* Demele, report that they once lived elsewhere on the terraces, where they would be nearer their fields. The aerial images suggest that people did indeed live in a more dispersed settlement pattern, though they still tended to concentrate in certain areas.

Historically, homesteads were frequently located on the least fertile, and often slightly elevated, lands across the landscape. A common pattern on all the terraces is for homesteads to hug the margin between the terrace and the ascending scarps. On Agay

Midir, for example, homesteads appear across the past half-century to concentrate along the skeletal Leptosols and exposed bedrock present on the western half of the terrace, and along its margin with the scarp. On the lower terrace, many homesteads similarly reside close to the scarp, with fields stretching out across the flatter open ground beyond them. Homesteads have also long been concentrated around the low rises of rocky ground in the middle of the two peninsulas at the southern ends of the lower terrace. The historic and archaeological settlements on Alem Doret are the only exceptions to this trend, being on the rocky but cambic soil there, though the conversion of such terrains to agricultural ground by necessity in the recent past may have been a short-lived or exceptional trend.

Recently, there appears to be a trend toward building small homes among agricultural fields away from the village and clustered homesteads. Since the time of the Bing Maps images used as the base layer for this project, two small daub and wattle *tukuls* were built on the eastern side of Tabot Madera away from other settlement concentrations, and another at Agay Midir at the eastern end of the settlements along the scarp, though distinctly separate from them and on agricultural land. All such homes, however, are far smaller and made of much more ephemeral material than the larger and more complex homesteads dotting the rocky prominences and slope margins. Residents pointed to these small, isolated homes and to the small clusters of homesteads on the rocky prominences in the region as more representative of the area's original settlement pattern prior to the growth and migration to Gännäta Maryam Village.

The re-emergence of these small homes perhaps represents the continued growth of the local population and demand for living space. Additionally, they and the clustered homesteads on marginal lands, similar in pattern to what is seen in the earliest aerial photos, probably illustrate what the traditional settlement pattern of the area had been like prior to the growth of modern villages. Likewise, they then hint at the types of features that may have produced the archaeological surface remains seen across the area, particularly in Tabot Madera. Perhaps not coincidentally, all three of the recent ephemeral *tukul* structures are near areas of relatively high artifact densities that predate the structures themselves. The study of the abandoned *tukul* on Alem Doret, discussed at length below, then not only provided insight into the effects of formation processes on the creation of archaeological contexts in general terms, but provides evidence for

comparing the surface artifact remains found elsewhere with those left by an abandoned home.

According to many residents, the disappearance of the small, ephemeral homes isolated in fields in the recent past and the abandonment of other homes like those on Alem Doret has been the attraction of amenities introduced in Gännätä Maryam village and other effects of modernization. In the aerial imagery (Figure 4.10), the growth of local settlement areas, especially the modern village of Gännätä Maryam is clearly illustrated. In 1965 one homestead appears in the location of the modern village. As residents recalled, people were attracted to the area over time because of the concentration of modern amenities introduced over the past few decades. Sometime between 1965 and 1982, the road through the region was consolidated from a poorly defined dirt track. A school house was built near the periphery of the modern village just below the church. According to the *kebele* administrator, the school was expanded in 2004, the clinic about the same time, and electricity was introduced in 2009. All informants reported that the availability of these resources has attracted people to the area from the surrounding region and that things like education and healthcare contribute to increasing population growth and longevity. Electricity though in particular led some residents like the owners of the homes on Alem Doret to move into the village.



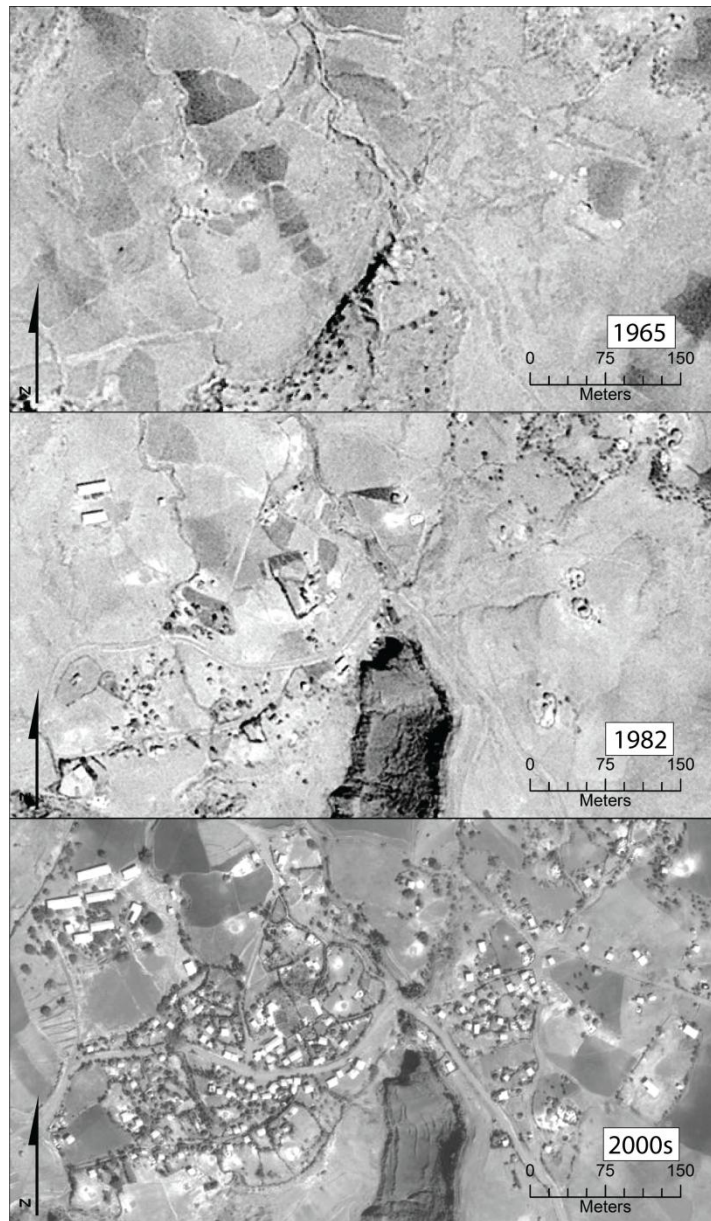


Figure 4.10. Growth of Gännäta Maryam Village. The school is visible in the upper left in 1982 to present. The clinic is visible in the 2000s as the rectilinear compound to the lower right. The western ascent of Tarla Terrara Hill is just barely visible in the upper right.

According to *kebele* records, in 2014 the population of the village of Gännäta Maryam was about 1,587 individuals, with a further 117 living outside the village across the three terraces of the study area. While no informant referred to this, it is also worth considering that an additional part of the Derg's social programs mentioned above was "villagization," or the encouraged, and at times forced, resettlement of people into nucleated settlements for the purpose of concentrating populations around infrastructure

and government administration (Dejene 1990: 14). No records on Gännäta Maryam's participation in this project, if at all, however, have been recovered, though the program was certainly implemented in the wider region and the timing of the growth of the town coincided with the program (Dejene 1990).

#### **4.6. (b) Oral history and ethnography: Systemic and archaeological contexts; the reuse, discard, and recycling of artifacts**

A key feature of Schiffer's Behavioral Archaeology as outlined above is a concern with the use-life of objects resulting in their ultimate deposition into the archaeological record. Schiffer rightly points out that rarely are objects used in their initial state in the same location as they are discarded. More frequently, the use-life of objects is complex and an object may cycle between different systemic contexts and the archaeological context (1972: 156, also in 1995: 25). Consideration of this process at Gännäta Maryam is important at least because so many observed or reported behavioral practices prove Schiffer's argument. However, in the analysis and interpretation it appears that more frequently these practices only further confound interpretation of archaeological remains like the significantly disturbed surface collections rather than supporting a stronger interpretation of the context and assemblage's significance.

The people of Gännäta Maryam, as likely most Ethiopians, espouse and practice a great deal of parsimony when possible with their material goods. Rarely is an object simply thrown out permanently once it has finished serving its primary function. For example, the blacksmith claimed that iron objects are rarely ever thrown out. They will virtually always be brought back to him to be repaired, re-sharpened, or reworked. Similarly, only a few relatively small fragments of grinding stone were found during surface collections. Far more frequently, spent grinding stones were found incorporated into architectural features like *tukul* foundations and *nas* walls. One farmer, upon hearing we were looking for old things, brought us to a tree near where we were working. He showed us a grinding stone he had recently plowed up in his field, and was now using it to step up to the branches of a fruiting tree. Similarly, we were pointed to the pit features excavated on Tarla Terrara by the farmer who initially found them capped by large, flat

stones. He did not disturb the pits, but took the stones to his home and used them as steps. The potters were observed using spent grinding stones to grind dried clay and pigments prior to potting, claiming they preferred heavily worn stones for the purpose rather than fresh, flat grinding stones. The former owner of the abandoned *tukul* on Alem Doret also claimed that some of the stones from his home had been used to make a bund on the edge of the slope behind the former home, and that others took stones from his and the neighboring abandoned *nas* for construction of their own homes.

Even broken ceramics were often reused. The broken tops of narrow necked pottery jars, consisting of the neck and shoulders, were frequently observed in use in Gännäta Maryam and elsewhere in Ethiopia as the caps holding together the gathered point of thatched roofs. Though just as frequently today, many homes may use modern tin cans following consumption of their contents for the purpose, as well as a myriad of others for such items. Broken pottery fragments were also seen being used as scoops and ladles, bowls and other open containers. Sherds were sometimes even chipped or abraded to fit as lids over pots like the traditional coffee pots. While observing Tsehaynesh at work, she also indicated one of her firing pits, where she used large broken ceramic sherds as a liner for the pit.

Regarding patterns of discard, all informants said they would usually just throw garbage and broken objects like pottery indiscriminately away from the homestead, whether it be into a field, a ditch, or over an embankment. For example, we questioned the owner of the former *tukul* on Alem Doret, prior to surveying the remains of his home. He claimed that if a pot broke and was unusable, large fragments might simply be tossed while small fragments were ignored. Where or how far the fragments were tossed, he claimed, was essentially unimportant so long as it was not obstructing any activity area. Bones and food scraps might be given to animals like dogs and chickens, or similarly tossed into the fields as fertilizer. Oddly, when interviewees were questioned about the pottery on the Vertisol soils, no resident seemed to understand why they were there. Residents claimed Vertisols are considered unsuitable surfaces for building homes because of their unstable shrink-swell properties and water retention. When asked if residents might salt such fields with broken pottery intentionally, perhaps to help aerate

the dense clay, few seemed to be familiar with the concept and professed they had no knowledge of such a practice being done in the region.

Following discard or entry otherwise into an archaeological context, objects are not necessarily guaranteed to stay there. Gännäta Maryam residents are just as curious about their past as any archaeologist and frequently curate artifacts they discover, even going so far as to put them back to use. *Ato* Dejene, for example, showed us a pot he had found on Tarla Terrara hill while plowing it. Not only had he kept the pot, but he had once painted it with the national colors of Ethiopia. Many other residents also came to us with well preserved archaeological pottery or other artifacts they had found. One resident claimed she used the pot her family had found for storing spices.

Children were also observed recycling and reworking materials. Children commonly play the Ethiopian equivalent of mancala, *gebeta*, a game played with two rows of holes. Each of two players starts off with a number of small game tokens. At Gännäta Maryam, gebeta holes were frequently seen in the soil around areas frequented by children herding their family's sheep and goats. Just as frequently, these holes still contained numerous small flaked stone artifacts which had clearly been gathered off the surface from the surrounding area. It appeared in some instances that the lithics had been smashed to reduce their size and multiply the number of available pieces (Figure 4.11).

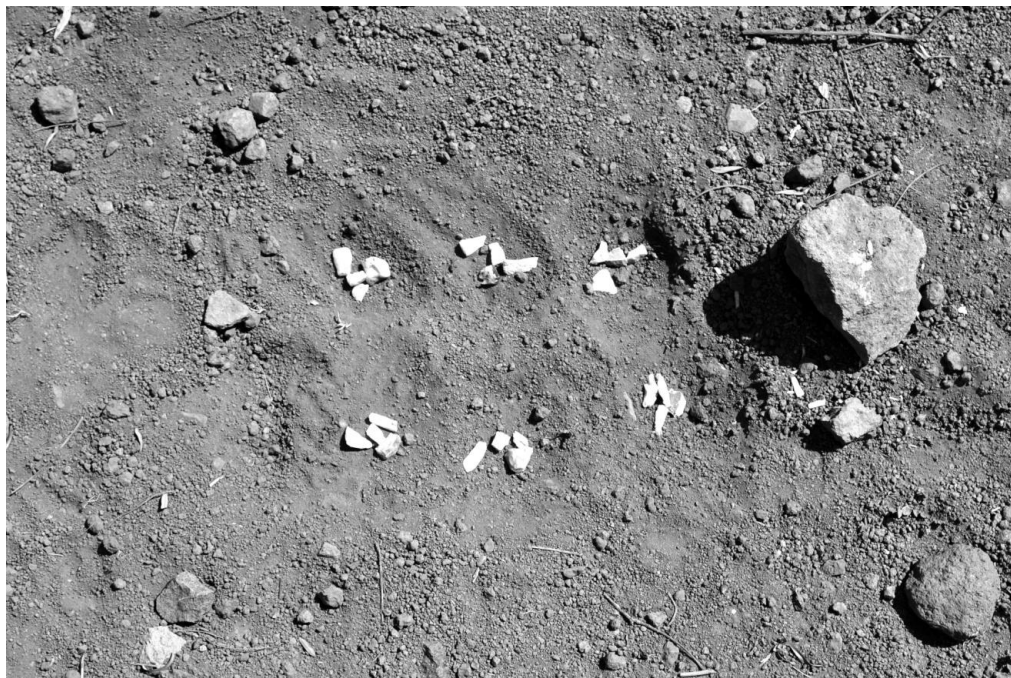


Figure 4.11. Chalcedony and chert lithics used by children as gaming pieces. The rock to the right had been used as an anvil to break up the lithic artifacts into smaller pieces or to increase the number of available pieces.

#### **4.6. (c) Oral history and ethnography: Agricultural practices, historical changes, and their effects on behavioral practices and the environment**

Agricultural practices as Gännäta Maryam as they are germane to this thesis may be divided into two categories: livestock practices, and planting practices. Livestock and their movement across the land has changed in the recent past in the face of government ordered hill slope closures, though their very presence alone may have an impact on archaeological site preservation. Agricultural practices meanwhile may pose little threat to site preservation in some instances, and great challenges in others.

The people of Gännäta Maryam consider themselves rather poor in terms of livestock. Informants claimed few families have more than two adult cattle reserved for plowing, if any, and only a small number of sheep, usually a breeding pair or a small flock. Due to a shortage of fodder and rangeland, informants claimed it is not uncommon for families to lease cattle from other residents when they are needed rather than face the annual upkeep themselves.

According to Dejene (1990: 22), residents of the Wollo area were considered to have among the largest herds of animals exclusive of lowland pastoralists in Ethiopia. This seems in marked contrast to Gännäta Maryam and the region today, though the reduction in animals may lie with the land reforms of the Derg. According to informants, prior to the land reforms of the 1970s and '80s, animals were pastured on private or communal property during the rainy/growing season, usually on slopes away from the wetter bottomlands. Following harvest, all animals were typically given free range to graze where they liked, including feeding on the stubble from harvested fields. The Derg's land reform policies, however, instituted two complicating policies for livestock holders. Land redistribution was intended mostly for the redistribution of agricultural land, without great regard for the needs of livestock (Dejene 1990: 27). This resulted in previously land-rich farmers having less private land on which to graze their cattle, forcing them to use communal pasturage. However, exclosure of hillsides intended to mitigate land degradation reduced unclaimed and/or communally held land available for pasturage. The result was that during Dejene's survey, 50% of respondents claimed they faced a shortage of grazing land and/or fodder for their animals during the rainy season when fields were closed off to animals for cultivation, and 33% claimed that even in the dry seasons, there was insufficient land available (Dejene 1990: 27).

One may assume that the effects of these pressures since Dejene's study has been an overall reduction in livestock holdings to meet the pressure imposed by limited resources, explaining the current sentiment among Gännäta Maryam farmers that cattle are in short supply due to expense of their upkeep. The steep slopes around Gännäta Maryam have indeed been subject to exclosure and further slopes continue to be closed off, with steep fines on farmers to violate the local exclosure policies. Additionally, the opening of hilltops to agriculture rather than leaving them forested, where they could serve as year-round grazing land, has also likely increased local pressure. Farmers are permitted to cut grass and scrub to feed their animals from the protected hillsides, but it is conceivable that this cannot satisfy needs as well as permitting the animals to browse the slopes themselves. Despite what appears to be a low number of browsing animals in the research area today, cattle, sheep and goats, undoubtedly have and likely continue to have an impact on land degradation and erosion. Their effects may not be as extreme or as

perceptible to surveyors today, however, the impacts they may have had in the past cannot be ignored (see Chapter 5 for analysis of the impacts of livestock on the land).

Crop cultivation does not seem to have changed so much as livestock management except in the opening up of fields in previously uncultivated areas as discussed above. Recognizing the extent of erosion and perceived declining soil fertility in the Highlands, however, a question asked of many informants was "do you ever let any of your fields fallow?" All farmers and informants responded that yes, fallowing was done in the past, though with increasing demand for land and low or declining soil productivity, fallowing remained desirable but was often incompatible with producing sufficient food annually for survival. Dejene reported similar sentiments in the 1980s, and states that only 5% of his sample population was practicing fallowing at the time for this reason, even though they, like the residents of Gännäta Maryam, recognized the consequences of this choice (1990: 28). In neighboring Tigray, Nyssen et al. also confirmed that fallowing was going out of practice due to population pressure (2008: 273).

#### **4.7. Shovel testing**

We began our first shovel tests (Figure 4.12) on the Vertisol fields of the northeastern quadrant of Tabot Madera, referred to as "Area A" to distinguish it from the southern half of the plain, dominated by the flat alluvial fields, "Area C." We then conducted shovel tests in Area C, and on Tarla Terrara, "Area B." Additional isolated shovel tests were then done in dispersed areas across Tabot Madera to confirm the absence of subsurface features and document the correlations between the presence/absence of surface artifacts, soils and stratigraphy, bedrock geology, and overall geomorphological setting. Final shovel tests were placed across Alem Doret. For a table of all the shovel test data, including soil descriptions, artifact content, and other pertinent data, see Appendix A.



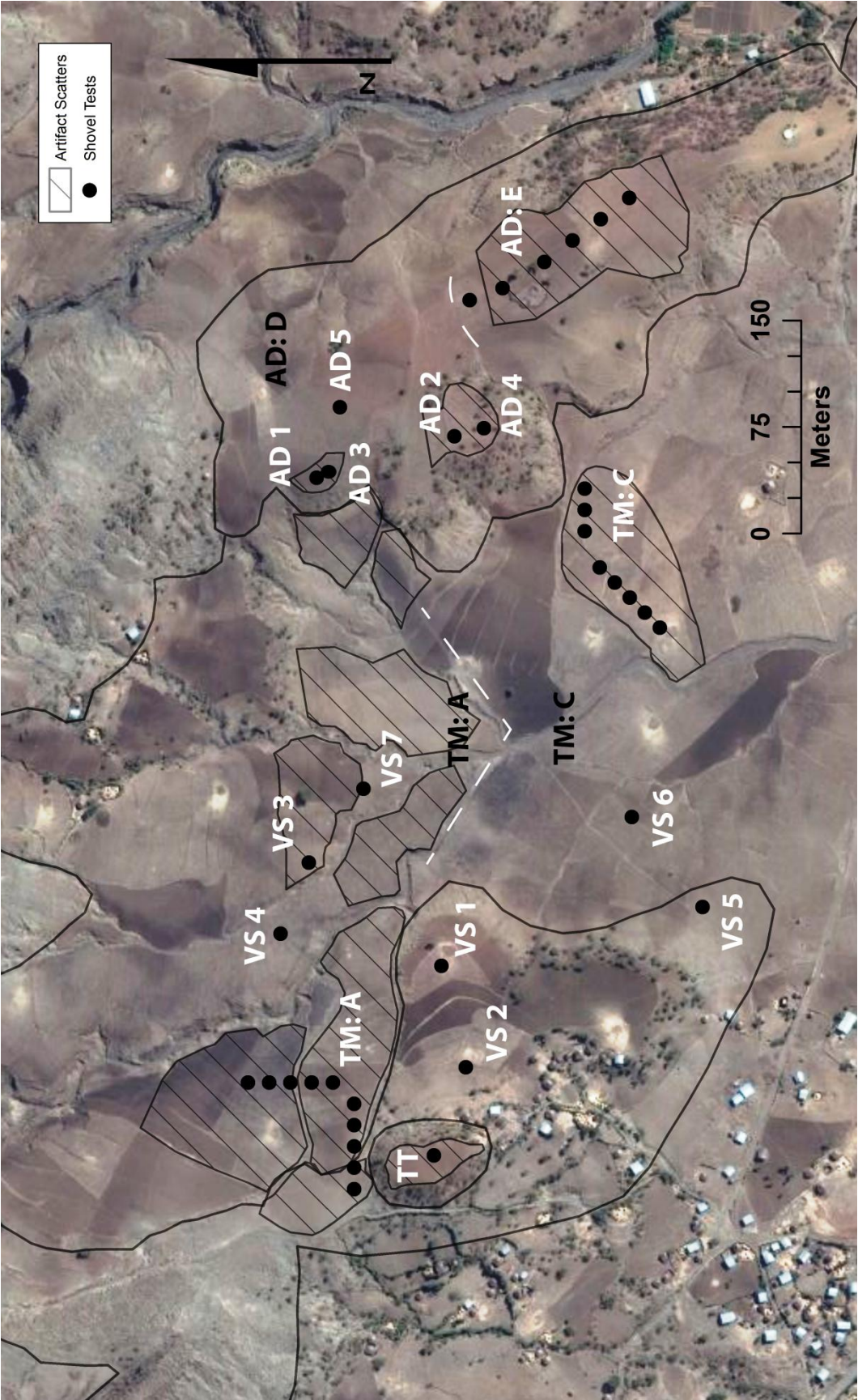


Figure 4.12. Locations of shovel tests on the lower terrace of the study area. TM:A and C are Tabot Madera, Area A, and C, respectively



#### **4.7. (a) Shovel tests, Tabot Madera, Area A**

The first shovel tests were conducted along a 75 meter transect, each shovel test spaced 15 meters apart, running north from a point selected at the edge of two field boundaries in Tabot Madera: Area A (Figure 4.12; for a summary, see Table 4.2). The central point was placed just north of two field boundaries, the northern field containing some of the most densely concentrated surface remains in the research area. Despite this concentration of artifacts, however, we recovered no artifacts from these shovel tests and later exploration suggested most of the artifacts were concentrated in the top few centimeters of plow zone. Furthermore, the plow zone stratum consistently ended at a depth of about 15 cm, the typical depth of Ethiopia's scratch plow as experienced here and at other sites. Beneath the plow zone was a strata of very hard, compact black Vertisol clay. During excavation and screening, we recovered no material from this layer and no further strata were encountered within the additional 35 centimeters excavated, suggesting that the clay is sterile. The only exception to this trend was shovel test 3, which was placed just inside a gulley dividing the two fields; the first 40 cm of this shovel test were dark, sandy soils transitioning gradually to alluvial gravel and finally dark, friable, basalt regolith.

Shovel tests along the western transect showed a distinctly different pattern. These shovel tests were near and ran parallel to a small embankment and gulley, while the final two were placed on the other side of a packed earth bund separating the field from the saddle of land linking Tarla Terrara and Agay Midir. The soil along this transect within the fields was visually distinct from the Vertisol, being a buff color and coarser, similar to that later found on Tarla Terrara. The first three shovel tests again showed a plow zone of about 15 cm over an additional 15 cm of gritty subsoil, before transitioning to friable regolith. The material was firm, but fractured easily into a buff-colored gravelly material with crystalline inclusions, possibly of calcite, when struck with our excavation equipment. No artifacts were found in the first shovel test, while artifacts were found in the plow zone and subsoil of tests two and three. Incidentally, these latter two were on a level field, while the previous shovel tests, West 1 and North 1 and 2 were

on fields with a slope descending roughly eastward by about 4.5° based on measurements of our shovel tests and surface collection units.

The final two shovel tests of the western transect rose over the saddle, which appears to be composed largely of the same buff-colored regolith capped by an eroded, leptic soil related to that seen on Tarla Terrara. A number of footpaths coming from different directions met on the saddle, and striations indicate a large area of the saddle had been plowed in the previous season. Shovel test West 4 fell adjacent to a hard-packed earthen bund, rising above the eastern field, essentially providing a profile of the inner side of the feature. A dense concentration of artifacts was found throughout this shovel test, and thin strata of alluvial or colluvial particles were distinctly visible beneath the top 25 cm of soil. By contrast, the final shovel test, West 5, placed nearer the ridgeline of the saddle, had a plow zone of only 10 centimeters, and a similar number of ceramic sherds isolated solely to the plow zone. Beneath the top 15 cm of soil, the earth transitioned to regolith. Surface collections in this area later document the exposure of regolith near the apex of the saddle to the southwest of the shovel tests.

Table 4.2. Summary of Tabot Madera, Area A shovel tests

Shovel Test Transect and #	Soil Profile	Artifact presence / absence	Notes
N1, N2, N4, N5	15 cm vertic plowzone over Vertisol clay	artifacts observed on surface, but none captured by shovel test; subsoil sterile	Shovel tests across sloping Vertisol fields
N3	Alluvial sand transitioning to gravel then regolith	No artifacts	Established gully between fields
W1, W2, W3	15 cm cambic plowzone over subsoil and regolith	Artifacts in plowzone of W2 and W3	Shovel tests sloping up cambic soil adjacent to vertic soil
W4	15 cm plowzone above fine strata of alluvial and colluvial soils captured behind bund	Artifacts through all strata	Shovel test located behind earth bund on saddle of land
W5	10 cm plowzone transitioning to regolith	Artifacts in plowzone	Shovel test located over ridgeline of saddle - evidence suggests area has suffered heavy erosion

From these shovel tests, it can be deduced that the lower fields are largely composed of a layer of very thick Vertisol clay overlying basalt bedrock, exposed

beneath the gulley which has cut through the clay. This transitions to the inselberg regolith that comprises Tabot Madera and the saddle, and the associated lighter, leptic soil formed from it. The bund dividing the saddle from the fields retains soil eroding from the saddle apex reducing the depth of surface soil near the apex and increasing the depth immediately behind the bund (Figure 4.13). As surface soil erodes, artifacts are carried with it and deposited in alluvial strata behind the bund, producing the depth and stratigraphy seen here but not present elsewhere. The principal of soil capture and terrace leveling is a common one in sloping areas divided by bunds and has been studied in depth in Ethiopia (e.g. Nyssen et al. 2000; Gebremichael et al. 2005).

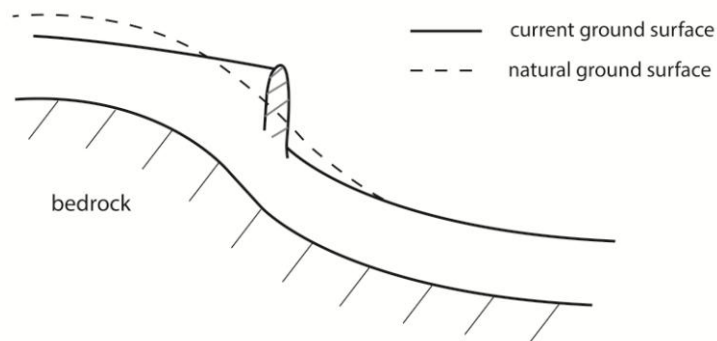


Figure 4.13. Diagram illustrating the principal of soil level change around the bund dividing the saddle from the northwest end of Tabot Madera (not to scale). The bund and erosive processes like plowing and trampling have changed the local environmental equilibrium, leading to soil accumulation behind the bund while decreasing the amount of soil near the apex of the saddle, bringing the bedrock closer to the surface. As a result, artifact-rich strata of eroded soil have built up behind the bund over the horizon of the original ground surface.

#### **4.7. (b) Shovel test, Tarla Terrara, Area B**

We conducted a single shovel test near the middle of Tarla Terrara hill, whose concentration of surface artifacts and soils were similar to the western edge of Area A. We conducted the shovel test in order to see whether intact subsurface remains might exist and to gauge the possible processes of erosion and deflation that may have affected the hilltop. The surface was an erosion pavement of gravel and artifacts capping plowzone soil. *Ato* Dejene confirmed that he had plowed the hilltop for cultivation at one

time, but had not done so in the previous few years. The plowzone, like that found on the saddle to the north of the hill where shovel tests W3-4 were excavated, was only about 10 cm deep, rather than 15 cm, likely due to erosion and surface deflation following the last episode of cultivation. Again, about 15 cm below the surface, the soil profile transitioned to friable bedrock, indicating that little soil has remained undisturbed from plowing in the area.

#### **4.7. (c) Shovel tests, Tabot Madera, Area C**

We then conducted a second series of shovel transects (Figure 4.11), summarized in Table 4.3, on the alluvial plain area of Alem Doret to the southeast of the study area. The eastern transect crossed a field bounded by packed earth bunds, elevating the soil surface about 4 meters above the level of the adjacent field of alluvium. The southwestern transect, by contrast, ran across three fields: the first in a field adjacent to and at the same level as the eastern transect, the second in a small field a little less than a meter below the first, and the third through fifth in the field bounded by the wadi, about a meter below the second. Placement of this transect group was dictated in part by limited access to surrounding fields as planting had already begun at this time. The eastern transect contained only three shovel tests, as the field was fairly small. Space between shovel tests and excavation methods were the same as those used for Area A.

All three shovel tests of the eastern transect were fairly similar. Each contained a plow zone which had not been plowed since the previous year's harvest, resulting in a slightly crusted surface covered in an alluvial wash of dark sand eroded from the adjacent slope about 15 meters north. The plow zones, perhaps due to erosion or compaction of the surface, were only about 10 cm in each instance, rather than the expected 15. All shovel tests achieved their maximum depth of about 80 cm though no discernible changes in soil color, texture, or stratigraphy was evident. Artifacts (ceramics) were found in appreciable concentration down to a depth of about 50 cm, after which only one ceramic was found.

Like the eastern transect, all southeastern transect tests were excavated to their maximum depth without reaching bedrock or definitively sterile soil. Shovel test Southwest 1 contained a very dense concentration of ceramics, and subtle changes in soil texture, eventually becoming very sandy, though actual stratigraphic interfaces were difficult to discern. Though artifacts became less abundant with each shovel test approaching the wadi, their vertical distribution throughout the shovel test units remained constant. Soil brought up with each bucket showed slight changes in texture and composition, though distinct strata could not be distinguished with such a rough method. Shovel test forms note that such changes were observed, but strata as recorded on forms likely overlook or incorporate numerous depositional units. As visible in the western wall of the wadi, it is likely that beneath the plow zone, the area is dominated by fine alluvial strata, and that shovel testing is too coarse a method to distinguish individual depositional layers.

Table 4.3. Summary of Tabot Madera, Area C shovel tests

Shovel Test Transect and #	Soil Profile	Artifact presence / absence	Notes
E1, E2, E3	10 cm cambic plowzone with surface of alluvial sand/gravel from slope over apparently homogenous soil	Artifacts found to depths of 60 cm	No distinctly visible stratigraphy, but may be a limitation of shovel testing method, or generations of soil accumulation and mixing by plowing
SW1, SW2, SW3, SW4, SW5	15 cm plowzone over alluvium	Artifacts found at all depths, though volume declines with each successive test	Soil beneath plowzone shows characteristics of stratified alluvium, though shovel testing was too coarse a method to distinguish individual strata

#### 4.7. (d) Shovel tests, Valley Survey

Because of limited space to work in as farmers began planting their fields, and the failures of shovel tests to acquire meaningful results per the original research plan, we abandoned the formal shovel testing regime of aligned, radiating shovel test transects in Tabot Madera. To confirm suspicions of the absence of undisturbed archaeological strata

in the area and gather sedimentary and geomorphological data, we placed seven shovel tests in disparate locations across Tabot Madera in areas not previously explored (Figure 4.11). As expected, these shovel tests recovered very few artifacts, but confirmed the associations of soils to geological features in the landscape and contributed to the production of the soil and geological maps shown in Chapter 2. Like the other shovel tests, full excavation records on these shovel tests, soils, and stratigraphy can be found in Appendix A.

#### **4.7. (e) Shovel tests, Alem Doret, Area D**

On the northern half of Alem Doret, we placed five shovel tests in various areas (Figure 4.11), summarized in Table 4.4, two with visible archaeological features associated with them. Because of the hill's exposures of bedrock, planted fields, irregular shape, and the ineffectiveness of the previous shovel testing pattern, we placed shovel tests judiciously to sample the archaeological potential of different areas similar to the Tabot Madera valley survey.

Shovel test one was placed in a semicircular prominence of land overlooking Tabot Madera. The area did not show signs of plowing in recent years, and artifacts were thinly distributed across the surface. Beneath 15 cm of soil, we encountered a mass of large rocks. The rocks were loosely fitted together and distinct from the bedrock and so it was deemed a possible feature. A second shovel test excavated five meters away revealed a stratum of dense, reddened earth with flecks of charcoal about 20 cm below the surface. We expanded this shovel test into Test Unit 1, discussed below.

We placed shovel tests three and four within the artifact scatter of the already identified abandoned *tukul* of Alem Doret. The soil in this area is thin, barely deeper than the plow zone. By about 20 cm in both shovel tests, the soil transitioned to regolith. Modern ceramics associated with the home were found in both units, concentrated primarily in the plow zone.

Shovel test five was near the midline of the ridge of the hill to round out the study of the area. The soil was fine and dusty, though as elsewhere, was little deeper than the

plow zone, about 15 cm. As elsewhere, the end of the plow zone quickly transitioned to sterile regolith.

Table 4.4. Summary of Alem Doret, Area D shovel tests

Shovel Test #	Soil Profile	Artifact presence / absence	Notes
1	15 cm of soil over collection of rock	Artifacts present in top 15 cm of soil	No sign of plowing in recent past. Rocks appear to be a wall feature
2	20 cm of homogenous topsoil followed by charcoal and burned earth to a depth of 36 cm. Transitions to regolith	Ceramics in topsoil, charcoal and possibly flecks of plaster or hardened ash beneath	No sign of plowing in recent past
3	12 cm of plowzone over loose subsoil, transitioning to regolith at 20 cm	Artifacts on surface and first bucket of soil from plowzone.	Near abandoned Alem Doret <i>tukul</i>
4	17 cm plowzone transitioning to regolith	Artifacts in plowzone and one beneath	Center of Alem Doret <i>tukul</i>
5	15 cm loose, silty plowzone transitioning to bedrock	No artifacts	

#### 4.7. (f) Shovel tests, Alem Doret, Area E

Next we excavated linear transects of shovel radiating over the ridgeline of the hill away from the recently abandoned *nas* structures on Alem Doret. Like the *tukul*, artifacts were densely scattered in the area, likely discarded from the homestead and further distributed by plowing and trampling. Given the shallow depths of the shovel tests on the northern part of the hill and the frequent absence of artifacts beneath the plowzone, these shovel tests were spaced further apart than previous transects, at 25 meters, in order to expediently survey and sample the terrain and its geological composition. Commensurate with expectations, soil below the plow zone was increasingly rocky with depth after 15 to 20 cm. In most areas, the rockiness was attributed to the appearance of regolith; however, shovel tests SSE 4-5 transitioned to hard packed soil/gravel and clay, respectively, but were sterile nonetheless. All artifacts were found in, or within a few centimeters of the plow zone.

#### 4.8. Profiles

We excavated two profiles out of the sides of fields in the alluvial plain of Tabot Madera (Figure 4.14) with the objective of observing stratigraphy and archaeological contents, though neither was ultimately found.

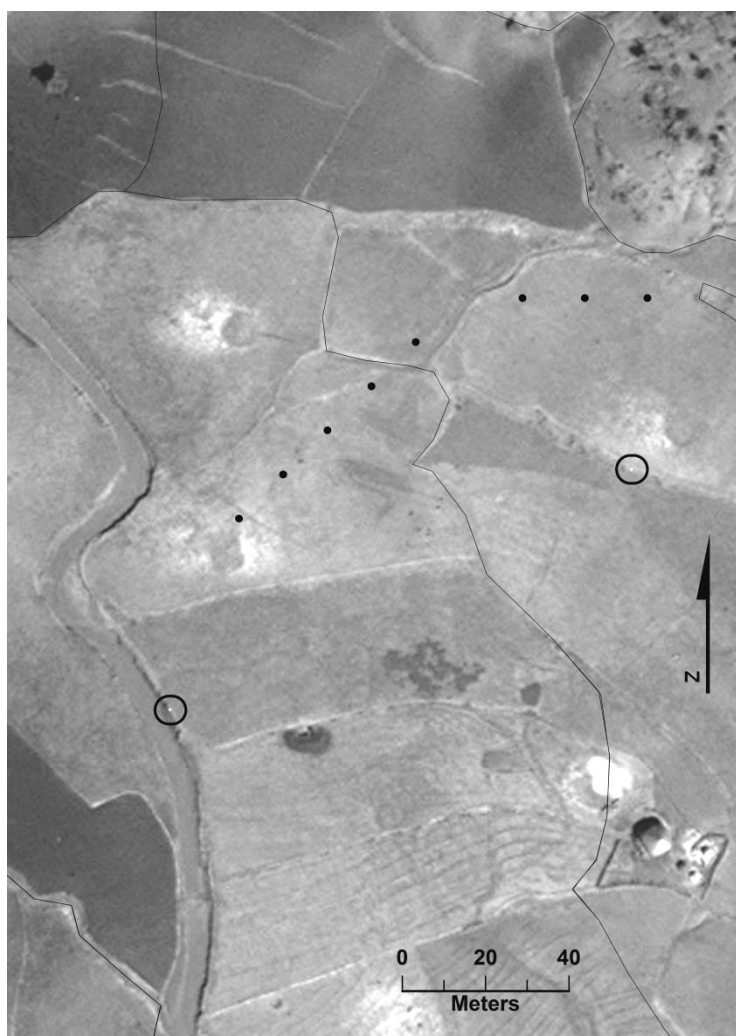


Figure 4.14. Wall profile locations circled, with nearest shovel tests, Tabot Madera: Area C represented for reference. Left circle is the wadi profile, right circle is the field terrace profile. The black line running between the two represents the approximate division of the area between alluvium (left) and mixed eroding soils (right).



#### **4.8. (a) Wadi profile, Tabot Madera ("Unit 2")**

We cut a half-meter wide and 25 cm deep profile into the eastern wall of the wadi, near the middle of the field south of that tested by the Southeast transect of the Tabot Madera, Area C, shovel tests (Figures 4.14-16). Contrary to indications of possible alluvial stratigraphy in the shovel tests in this field, the profile exposed a homogenous soil column. The soil profile showed the expected 10 cm stratum of disturbed surface soil, followed by a further 50-70 cm of dark, undifferentiated subsoil. Below this was a stratum of Vertisol clay descending beneath the wadi bed. No artifacts were recovered from this excavation.

By contrast, the natural wadi profile to the north of the excavation area showed a more dynamic picture. Below the regular surface of topsoil were irregular layers of finely bedded alluvial sand, loose soils and small stones, and areas of large rocks in a soil matrix. Similarly, the opposite wall of the wadi a few dozen meters north was cleaned and photographed, showing numerous strata of thin, finely sorted alluvium (Figure 4.15). This was capped by a crumbly mass of vertic plow soil distinct from the sandier alluvial strata beneath. While the absence of stratigraphy in the excavated profile is difficult to explain, one possible explanation for the overall notable differences in profile compositions may come from local practices of soil management. As stated earlier, informants claimed and we observed that the wadi walls are frequently buffered against further erosion by farmers, while areas like cut banks might be built up. The presence of fine, well-sorted strata are very likely fluvial deposits, but the irregular patterns of large rocks and undifferentiated soils may be the results of generations of wadi-human interaction. As the wadi meanders move, residents regularly shore up cuts and undercuts, or fill in point bars, all likely resulting in strata of discrete soils. Alternatively, the homogenous soil may be the result of meander scrolls, backfilled channels which are then progressively cut away again as the sinuous movement of the channel continues. Referring back to Figure 4.14, one can see that the current wall profile, excavated just south of the S-curve meander, was cut into soil that 30 years ago was many meters inland, and 30 years from now may be in the middle of a field again.



Figure 4.14. Wadi profile ("Unit 2"). The wall profile at the eastern side of the wadi where no discernible stratigraphy was noted. The profile ends as the Vertisol horizon; note the vertical cracks characteristic of Vertisols.



Figure 4.15. The east wall wadi profile (left) compared to the west wall of the wadi (right), scrapped slightly to highlight stratigraphy. Note the contrast in stratigraphic profile between the two.

#### 4.8. (b) Earthen terrace riser profile, Tabot Madera ("Unit 3")

We excavated another wall profile along the same plan as Unit 2 into the wall of the terrace through which ran the eastern transect of the Tabot Madera, Area C (Figures 4.13 and 4.16). Similar to the previous profile excavation, we recovered no artifacts. The soil was a light, clay-rich and very hard-packed dry medium that came to a clay substrate roughly level to the adjoining field about 80 cm from the surface of the wall. At first glance it seemed unusual that we recovered no artifacts when the nearby shovel tests has been so productive. However, it is possible the terrace bund was built up from soil distinct from the material retained behind it and thus does not represent the natural soil column itself, and so cannot be taken as representative of the field's vertical contexts.



Figure 4.16. Profile of the terrace riser between adjoining fields on the eastern side of Tabot Madera, Area C. The soil was a densely-packed homogenous mass of clay-rich soil.

#### 4.9. Excavations

We undertook six excavations, comprising four one-by-one meter test units and two larger horizontal excavation units during fieldwork, excluding the work done at the cemetery. Individual maps for each unit or area of units are provided with other fieldwork areas designated for reference; however the following map (Figures 4.17-18) provides an overview of the location of all excavations.





Figure 4.17. Location of excavations and wall profiles on the lower terrace. Shovel tests shown for reference.

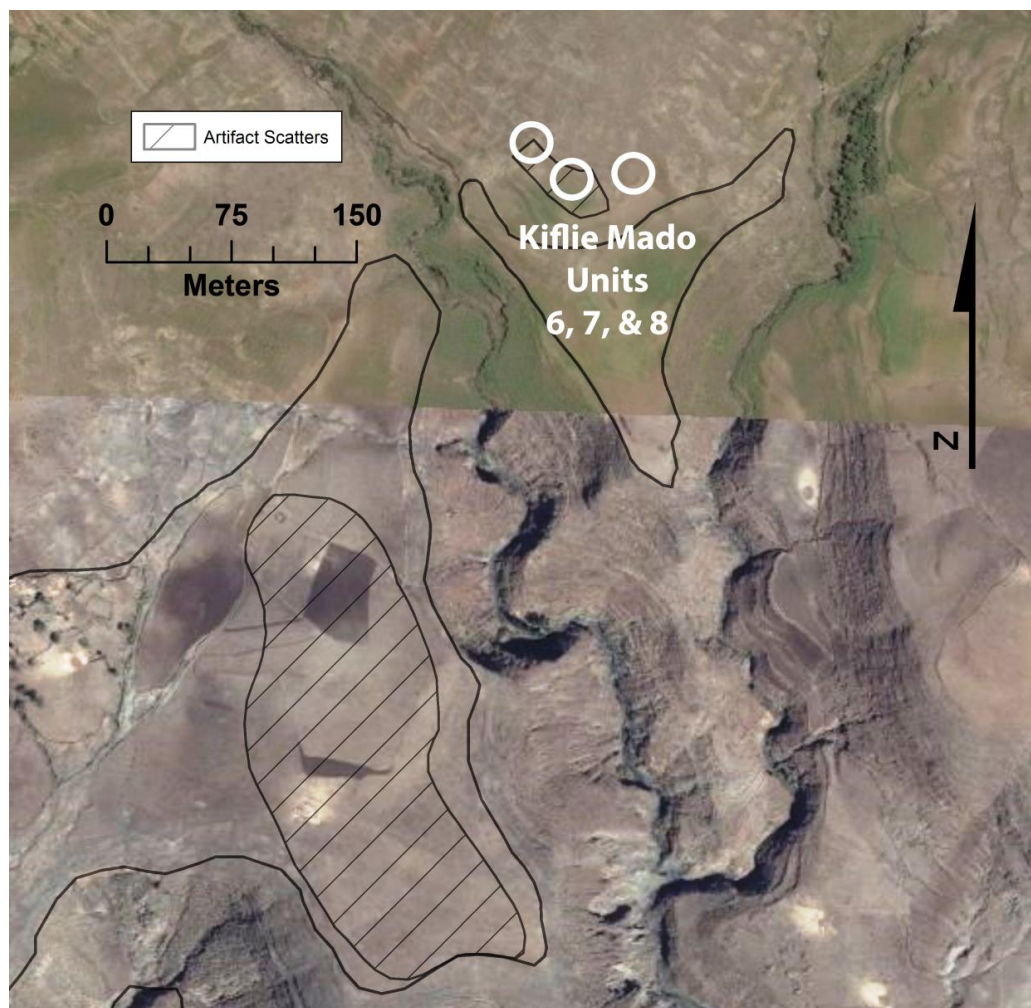


Figure 4.18. Location of the units excavated at Kiflie Mado circled, numbered sequentially from left to right.

#### 4.9. (a) Unit 1: test unit at Alem Doret, Area D

The first excavation was adjacent to the Alem Doret Shovel Test #2 (Figure 4.19). It was a one-by-one meter unit adjacent to Alem Doret, Area D shovel test 2, following the discovery of possibly burned earth there near the stone feature uncovered in shovel test 1. While the excavation identified an area of apparently burned earth flecked with charcoal, there was no obvious evidence for an anthropogenic origin such as a hearth ring or other features. A few artifacts were found in the soil above the burned earth, though none in direct association with it (see Table 4.5 for summary of stratigraphy). Because of

the low artifact density and absence of clear features, further excavation here was given low priority. Instead, we gave preference to excavations elsewhere, with the possibility that we might return to this location if time allowed. While artifact density was low, artifacts were also noted on the surface of the field below the slope of this part of the hill and may perhaps have originated here.

Table 4.5. Unit 1: Alem Doret, Area D test unit summary table

Locus	Avg. Depth and Stratigraphy	Artifacts	Notes
1001	15-20 cm: surface soil - coarse, sandy	Some ceramics and lithics recovered, mostly on or near surface	Compacted earth with erosion pavement surface
1002	15-45 cm: subsurface soil, mottled clay-rich soil with charcoal and burned areas	Some non-diagnostic ceramic sherds and a piece of lithic debitage	Clay stratum with patches of burned earth and charcoal
1003	45-70 cm: same as above transitioning to regolith	No artifacts recovered, possibly sterile	25x25 cm subunit excavated over burned earth. Sterile; transitioned to regolith



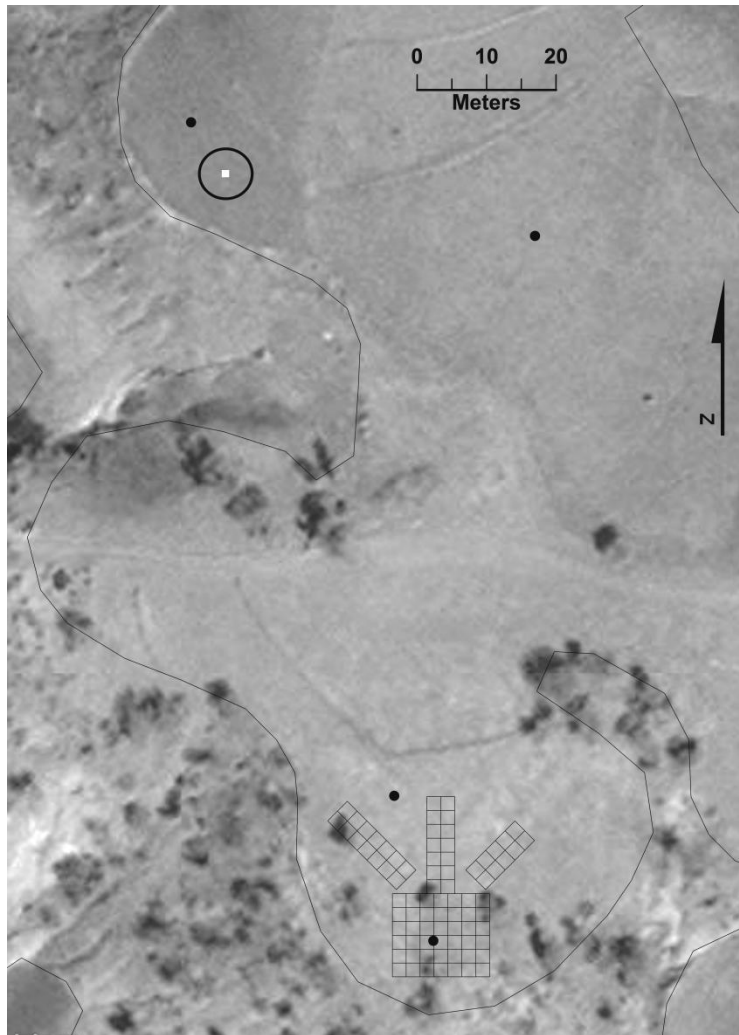


Figure 4.19. Alem Doret test unit (Unit 1) circled top left, shown with shovel test locations and Surface Collection L (bottom, center) for reference. The circle for shovel test 2 was removed for clarity, as the two were immediately adjacent.

#### 4.9. (b) Unit 4: Tarla Terrara Hill

While working in the region during our second season, the owner of Tarla Terrara Hill confirmed that he had encountered archaeological remains on the hill previously. Besides a complete pot he had recovered on the hill's southern tip, now covered in *Opuntia*, he reported encountering a series of large holes excavated into the lip of the hill's northeast side while he was digging a bank-and-ditch feature to capture runoff and reduce soil loss. Subsequently, we placed a two-by-six meter unit perpendicular to the



hillslope, covering ground from the top of the hill to a transect of the recent ditch feature (Figure 4.20). The soil was shallow, about 10-15 cm on average, before transitioning to regolith and bedrock. The bedrock, like the regolith, was slightly mottled in colors of pale browns and yellows. No features were found in the soil or on the bedrock surface, and given that the field had been plowed numerous times previously, it is unlikely any would have survived. However, as the land owner had indicated, two large holes cut into the bedrock were identified at the edge of his drainage trench (Loci 4006 and 4008 to 4009) (Figures 4.21-23).

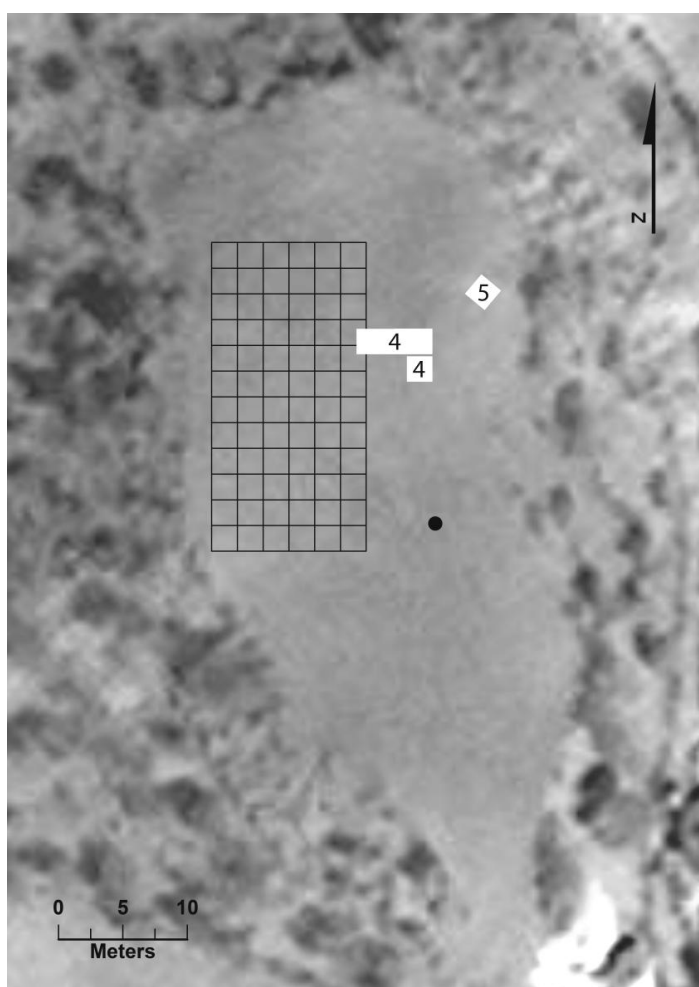


Figure 4.20. Locations of Units 4 and 5 on Tarla Terrara Hill, shown in relation to the shovel test (dot) and surface collection conducted the previous season (grid).



Figure 4.21. Western end of Unit 4 facing south, Locus 4008/9 in the foreground and 4006 in the background. The recently created erosion control ditch cuts over both features.



Figure 4.22. Photograph of Locus 4008/9, the larger of the two pit features.

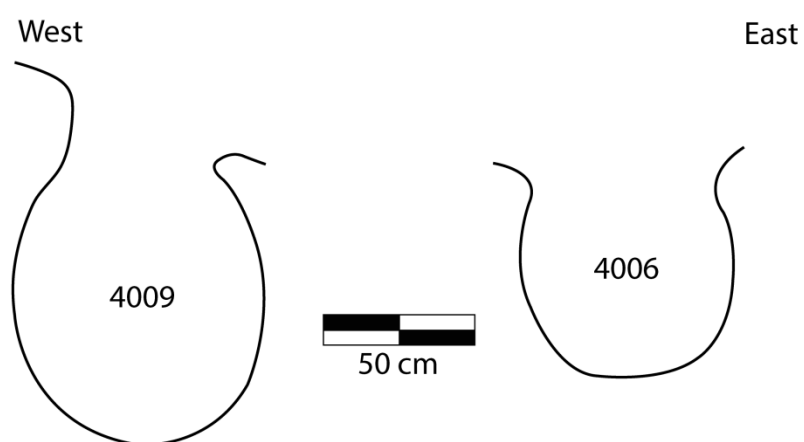


Figure 4.23. Profile of the two pit features, whose openings have been partially truncated by the recent creation of the erosion control ditch.

According to the farmer, these pit features had initially been capped with large, flat stones, which he has since incorporated into the construction of his own homestead structures. His trench had truncated the restricted openings of the pits by an estimated 25 centimeters, but did not otherwise disturb them. The features had apertures of about 50 - 60 cm with rounded cavities in profile (Figures 4.22-23.). The larger of the two features had a depth of 90 cm, and the smaller, about 75 cm. The pits were filled with a seemingly homogenous fill of loose dark brown soil. Both contained copious volumes of small animal bones, charcoal fragments, and a single iron wire or pin. While excavating the feature, Habtamu Tesfaye stated that he perceived bones were more heavily concentrated in the eastern half of the pit, though there appeared to be no intentional arrangement. In contrast to the volume of animal bones recovered from the feature, less than a dozen ceramic sherds were recovered from the two pit features. At the bottom of Locus 4008/9 was a roughly 12 kg stone which appeared to have come from the scarp rising above the lower terrace of the study area rather than from the hill itself. It appears to be the same type of stone as those recovered by Ato Dejene from the surface of the pits, though it was smaller in size.

Preliminary analysis of the bones by Dr. Christopher Tribe (pers. comm., 2014) indicates a mixture of avian bones, including some possible chicken or francolin, and small mammals, mostly belonging to Order: *Rodentia* (see Appendix D for preliminary statement on faunal remains from Dr. Christopher Tribe). Unfortunately, the largest bag of bones from the larger of the two features has not yet been examined. A charcoal sample from the larger feature returned a date of  $250 \pm 30$  BP ( $1\sigma$  Cal. AD 1640-1660), with a  $2\sigma$  deviation ranging from AD 1530 to 1950 (see Appendix B for full radiocarbon results).

We extended the unit at its eastern end to the north and south roughly following the line of the two pit features. At least one additional pit feature was found, also disturbed by the drainage trench, though we left it unexcavated for the time being.

#### **4.9. (c) Unit 5: Tarla Terrara Hill**

We placed a second unit on Tarla Terrara Hill to the east of Unit 4 on the steeply descending slope of the hill (Figures 4.20, Figures 4.24-25). During the previous field season a large pit feature, similar to those excavated above, was shown to our team. It had reportedly been excavated by unknown individuals without the landowner's permission for unknown reasons. The pit was cut into bedrock like those found in Unit 4, and was filled with white ash. We placed a two-by-two meter unit a few meters south of this disturbed feature where another pit feature was discovered.

As expected, the surface soil in this area was again thin, descending to regolith in the northern half of the unit. In the southern half, the regolith sloped into a gully. This gully had since been leveled by a 20-30 cm thick layer of white ash, beneath which was a thin (5-10 cm) layer of native soil. Beneath this soil was an additional pit feature cut into the gully. The aperture of the pit extended beyond the southern and western boundaries of the unit, but was roughly circular, with an estimated diameter of 1 - 1.5 meters. This tapered inward over 10 cm in depth to a straight-sided, flat-bottomed circular feature about 55 - 60 cm in diameter and 15 cm deep (Figure 4.24).

Burned bones were found in the ash layer covering the pit, and further, mostly unburned bones in the pit itself. C. Tribe's preliminary analysis of the bones (2014) suggests most are likely fragments of sheep, with a few cattle remains. A piece of charcoal recovered from the interface between the pit feature fill and the overlying ash layer returned a radiocarbon date and calibration virtually identical to that from Unit 4, suggesting the two features may have been contemporary and perhaps part of the same cultural context. The stratigraphic profile of the unit's south wall shows that the pit feature was cut, the lower vertical section was filled, and a layer of soil, then ash, and then soil either washed into or were thrown over the remaining depression from upslope (Figure 4.25).



Figure 4.24. The pit feature from Unit 5. The pit feature appears to have been cut into a slight gully or depression in the sloping hillside. It was subsequently filled with layers of earth and ash, containing numerous bone fragments. Further layers of earth and ash covered the area level to the current ground. The friable bedrock above the north arrow was accidentally cut away by a local crew member, creating an artificial step where there should have been a slope.

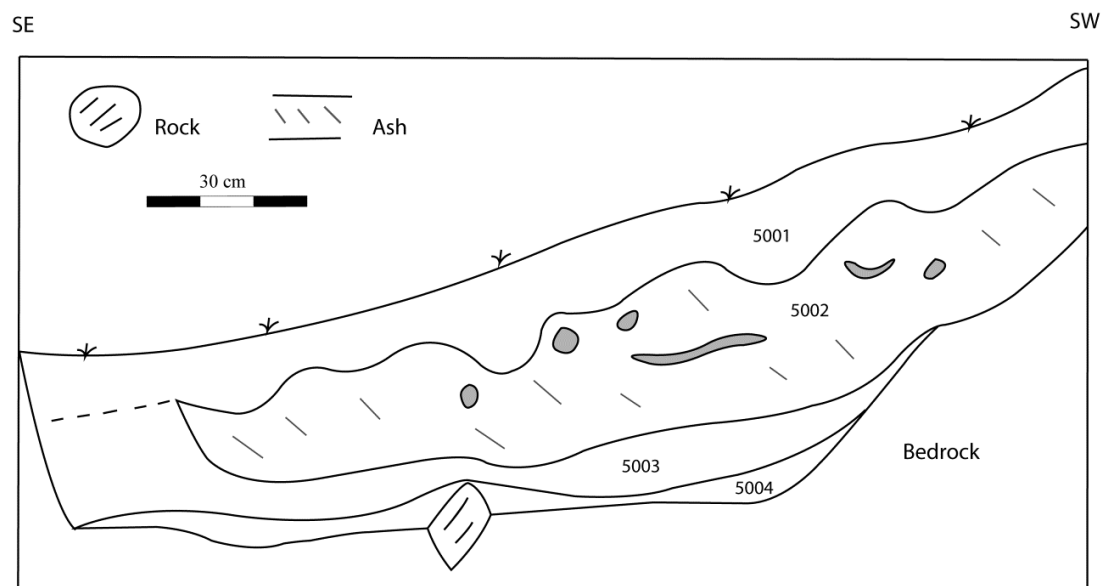


Figure 4.25. South wall profile of Unit 5, showing layers of soil and ash likely washed over the surface. Locus 5001: surface colluvium. Locus 5002: ash lens containing charcoal. Locus 5003: colluvium between ash layer and regolith, identical to soil in 5001. Locus 5004: gravely regolith transitioning to friable bedrock. The aperture to the pit feature (Loci 5006 and 5007) lies within centimeters of the south wall profile

As of now, it is difficult to say what these pit features from Units 4 and 5 could be and why they appear to be concentrated around the circumference of the hilltop. *Ato* Dejene and another local farmer claimed no knowledge of the use or origins of such features. Asked if they could be used to store grain or other foods, they replied that such an application would be unlikely given that it would leave the foodstuffs prone to infiltration by vermin. The soft, loamy soil and bone and ceramic content of the pits from Unit 4 could suggest a refuse pit or latrine, though this would be inconsistent with contemporary practice. Furthermore, the proximity to the slope of the hill might make such a use superfluous. The challenge of digging such large pits into the friable bedrock and the import of the large stones found in them add further mystery to their origin and function.

#### **4.9. (d) Unit 6, Kiflie Mado**

We excavated a one-by-one test unit on the pile of consolidated ash discovered eroding down the mountain slope a few meters west of the end of the slag field (Figures 4.26-27). The ash pile, as it remained, was about 2.5 meters long, about a meter wide, and sloping about 15°. Its terminal end was truncated by the excavation of an erosion control ditch, with a wall opposite the ash feature, while its upper end begins at the point of the ascending slope where soil at the foot of the slope gives way to exposed bedrock.

Though the ash pile did not contain any visible stratigraphy, and was only about 50 cm deep, it provided a wealth of material remains. Numerous large fragments of well-preserved pottery were recovered from the feature. Superficial examination suggested they represented potentially different styles than the excavations and surface collections on the other terraces (see discussion in Chapter 6). A small coil of twisted iron and other metal scraps along with numerous bones, most unburned, were also recovered. Dr. Christopher Tribe's cursory faunal analysis (pers. comm. 2014) suggests the majority of bones are likely from domesticated species such as sheep, cow, and chicken, though a number of bird bones were more "slender" than chicken bones, possibly francolin (*Pternistis* sp.).

Interpretation of the ash heap is uncertain, though it was likely some form of refuse midden, perhaps from a hearth, smithing area, ceramic firing pit, or all of the above given the presumed presence of all three activities as remembered in oral history and partially confirmed by the nearby presence of slag and the domestic hearth. Presumably the ash originated from numerous independent episodes of disposal given its size, though this cannot be confirmed. The absence of any obvious stratigraphic interfaces might instead be taken to suggest that a single depositional episode was possible, though where so much ash could have come from is equally as mysterious. The concentration is further unusual when one considers the contemporary practice of many people to throw hearth ash and other similar debris into fields where it may act as fertilizer. However, if the ash came from the activities of potters and blacksmiths not regularly employed in farming, perhaps there was no consideration for such a practice.

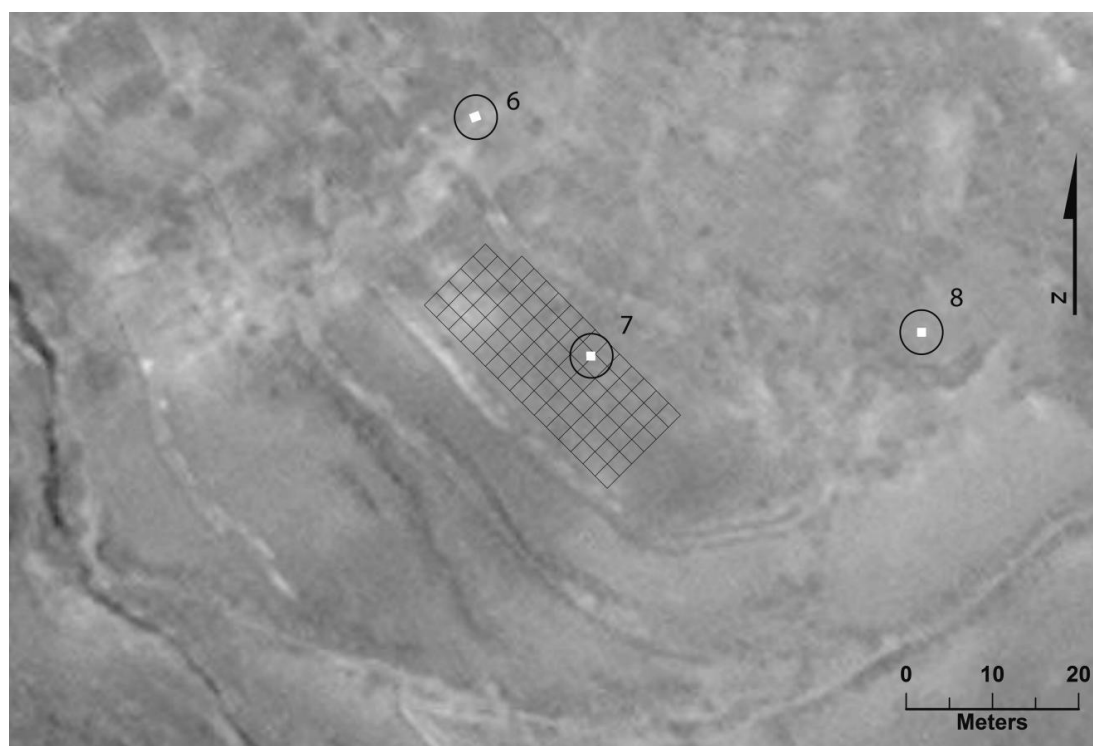


Figure 4.26. Kiflie Mado excavations (Loci 6, 7, and 8) with surface collection grid for reference. Local features described in the text are visible here. The pale area descending from Locus 6 is possibly layers of ash eroded off the ash midden. The gully is the slightly darker area immediately adjacent to the left. Surface collection O and Locus 7 are the highest area of soil before the slope transitions to colluvial gravels/lithic Leptosols and exposed bedrock. Locus 8 is located near the middle of the semi-circular accumulation of earth retained by the remnant wall feature along the south and southeast sides. Note the faint radiating gully head between the eastern point of surface collection O and Locus 8.





Figure 4.27. Opening and closing photographs of the ash midden at Kiflie Mado. The head of a gully eroding into the bedrock is partially visible in the upper left. The slope transitions from soils to lithic Leptosols and exposed bedrock above the midden.

#### 4.9. (e) Unit 7, Kiflie Mado

I placed Unit 7 near the top of the field where we had previously conducted surface collections of the slag distribution (Figure 4.26). The unit was a one-by-one meter test unit on the upper half of the field where the gradient was about  $8^{\circ}$ , considerably more level than the slope lower on the field. Soil depth was believed to be shallow, given the appearance of bedrock on the slope above and outcrops in the field below. Contrary to this prediction, however, we took a subsection of the excavation to a depth of 85 cm below the surface without reaching bedrock. However, we found no artifacts beyond the top 20 cm of soil, and the unit was closed. The excavation recovered slag and ceramic sherds consistent with the material found in surface collection O. The

soil throughout the unit was a fine, densely-packed clay-rich silt, with numerous large rock fragments.

#### **4.9. (f) Unit 8, Kiflie Mado**

We placed our final unit in the middle of a flat zone of soil, across a shallow gulley from the field in which Unit 7 was excavated (Figures 4.26 and 4.28). The area was small, but notable for an old semi-circular wall foundation buffering the soil against further erosion down the slope. The land owner had claimed a blacksmith-potter family lived in the vicinity and, contrary to our initial interpretation, the wall was not an agricultural terrace wall, but a remnant of an architectural feature. The unit is exceptional for the well preserved living floor and cooking hearth preserved beneath a layer of colluvium and fine strata of alluvial sediments. The sediments likely accumulated as the wall retained soils eroding off the ascending slope, also changing the area's topography (see Table 4.6 below and Figure 4.28).

Table 4.6. Unit 8: Kiflie Mado test unit summary table.

Locus	Avg. Depth and Stratigraphy	Artifacts	Notes
8001	5-10 cm: fine, silty plowzone	A few ceramic sherds	plowzone
8002	10-30 cm: unplowed subsurface soil	sterile	
8003	30-100 cm: thin, hard laminae of fine clay and silt between larger strata of sand and silt	sterile	A thick layer of sediment clearly deposited by overland flow events terminating on the surface retained behind the wall
Interface 8003 - 8004	Rocks		A concentration of rocks embedded in 8004 and projecting into 8003 presumably from the disintegration of the structure there; rocks are similar in size to those left behind from Alem Doret <i>tukul</i>
8004	100-110 cm: clay-rich silty soil	A few large, well-preserved ceramic sherds * Charcoal sample dated from interface between this stratum and 8005	Presumably the alluvium/colluvium or disintegrated daub accumulated over the structure's living surface following abandonment
8005	110+ cm: very hard-packed clay-rich silty soil	2-3 ceramic fragments, probably of the same vessel found on the surface of this stratum. * Charcoal sample, see 8004	Density, association with 8006, and absence of artifacts beneath surface suggest this may have been the original living floor
8006	110-145 cm: ash and charcoal	A few well-preserved ceramics, all with features suggesting they were used for food preparation. *Charcoal sample dated from this feature	Circular feature lined with flat stone and filled with ash. Only half exposed in unit. Residents confirm such features are cooking hearths as made and used today.

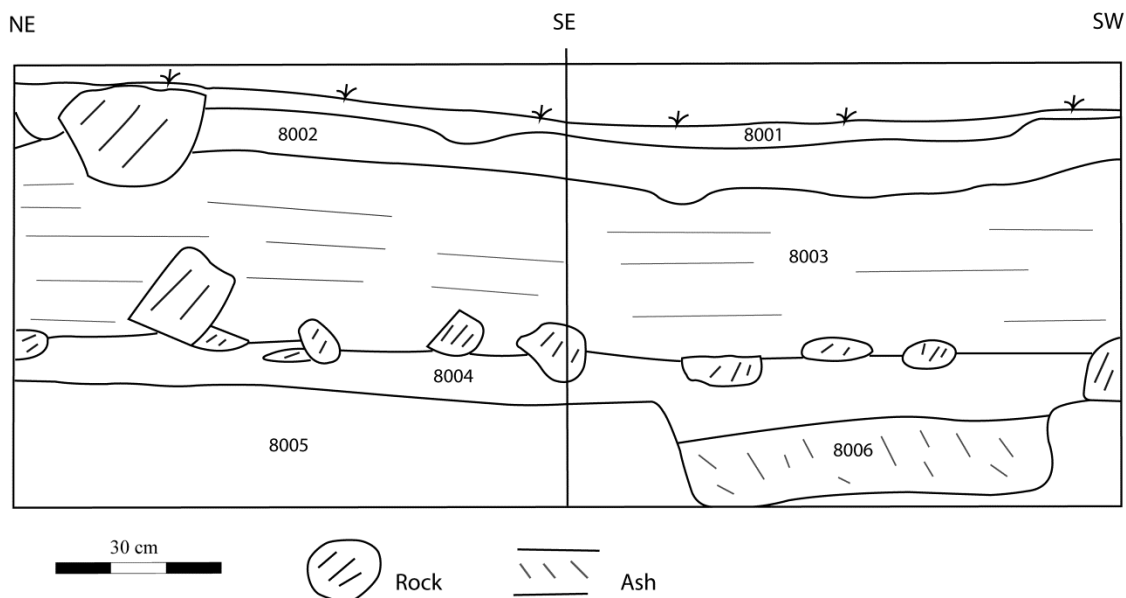


Figure 4.28. Wall profiles of Unit 8, Kiflie Mado and their loci. Locus 8001: plowzone. Locus 8002: unplowed surface soil stratum. Locus 8003: fine laminae of sand, silt and clay, with rocks and cobbles resting at the interface between 8003 and 8004. Locus 8004: silty soil. Locus 8005: hard-packed earthen surface with no artifacts, presumed to be a living floor associated with the hearth, Locus 8006. Locus 8006: circular pit filled with ash, charcoal and lined with vertically oriented flat rocks.

Radiocarbon dates of two charcoal samples recovered from the interface of the living floor and the overlying soil (Loci 8004/5) and the hearth (Locus 8006) suggest occupation of the area may have been historically recent (see Appendix B for full report). The first sample from the interface of Locus 8004 and 8005 provided a date of  $180 \pm 30$  BP with a  $1\sigma$  and  $2\sigma$  deviation as early as the mid 1600s and as late as post-1950s. Similarly, the second sample from the hearth returned a date of  $40 \pm 30$  BP, with a  $1\sigma$  deviation from 1900 to post-1950s. The current landowner did not know when habitation of the area had been abandoned, though he was aware, as suggested above, that a family had lived in this vicinity not too long before he acquired the land in the 1970s land redistributions. No structure is visible in aerial images, however, so the home must have been abandoned prior to the 1960s.

Analysis of the slag found in the adjacent field where surface collection O was conducted showed that the slag is smithing slag, not smelting slag (David Killick and Peter Robertshaw, pers. comm.). Ababu Gubay, the current blacksmith in Gännäta Maryam, noted that blacksmiths in the area stopped smelting iron early in the 20th century when foreign iron became ubiquitous enough to serve most blacksmiths' needs.

Together, the presence only of smithing slag, the intact nature of the ash heap (if it is associated), the local memory of the area's inhabitants, and the radiocarbon dates pushing into a 1950s date all suggest relatively recent occupation, probably during the early to mid 20th century.

#### **4.10. Cemetery Excavations**

As explained above, we conducted rescue excavations at the recently rediscovered cemetery at Gännäta Maryam on behalf of Dr. Tania Tribe. Burials in this region of Ethiopia are often shallow trenches covered with a low mound of rock and earth (Figure 4.29). At the church cemetery, however, many bones could be seen protruding at near the top of the partially profiled hillslope, often only 30 or so centimeters from the surface (Figure 4.30). No clearly visible covering of rock and earth appears to remain on many of these interments. Meanwhile, at the bottom of the slope where a large section of the slope had been cut away for road expansion, a number of articulated human remains could be seen sticking out of the profile far below the ground surface. We conducted an excavation on one of these burials, as well as excavations elsewhere up the slope that were ultimately irrelevant to this thesis.





Figure 4.29. Traditional cemetery burials outside of Lalibela composed of rock and earth mounds over shallow interments



Figure 4.30. Fragments of bone protruding from the recently profiled slope leading to Gännäta Maryam Church, centimeters below the top of the slope. To the right, cranial fragments and a long bone can be seen. To the left, further long bone fragments are exposed.

The excavations revealed that the slope is a mass of poorly consolidated rocks and sandy soil. The original aspects of the slope are difficult to determine now that paths

have been cut into it and the retaining walls have been constructed, though it was probably a typical convexo-concave shape, with the maximum slope angle appearing to have been about  $35^\circ$  (Figure 4.31). Though the roads cut up the lower section of the slope, it appears the slope may have leveled off somewhat before descending steeply again into the bounding ravine. The primary excavation of concern here occurred at this low-angled area exposed by the recent road cut.



Figure 4.31. The recently profiled and walled slope leading up to Gännäta Maryam Church in 2012. The road has been present for at least a decade, the old road bed roughly correlates to the gray surface while the recent cut into the hill is marked by the red bedrock. The approximate location of the cemetery excavation discussed here is just behind the figure's left shoulder. The figure is Habtamu Tesfaye, the project's government minder.

The first and most relevant area chosen for excavation was along the lowest portion of the profiled slope where the road cut had exposed articulated skeletal remains and the profile of a burial mound (Figure 4.32). The burial had cut into the top few centimeters of red bedrock, and the resulting mound fill was thus tinged slightly redder than the overburden. The top 20 cm of soil were primarily unconsolidated gravel and large rocks interdigitated by a mat of vegetation. Beneath this was a further 20 cm of densely packed gravel and coarse soil before the top of the known burial mound became



visible. However, within these 20 cm, indistinguishable from the surrounding soil, was another, previously unknown burial. Completion of the excavation showed that the more recent burial had skimmed over the surface of the older burial on a tangent, while the loose, rocky grey soil obscured the presence of the younger burial's mound, if such existed.

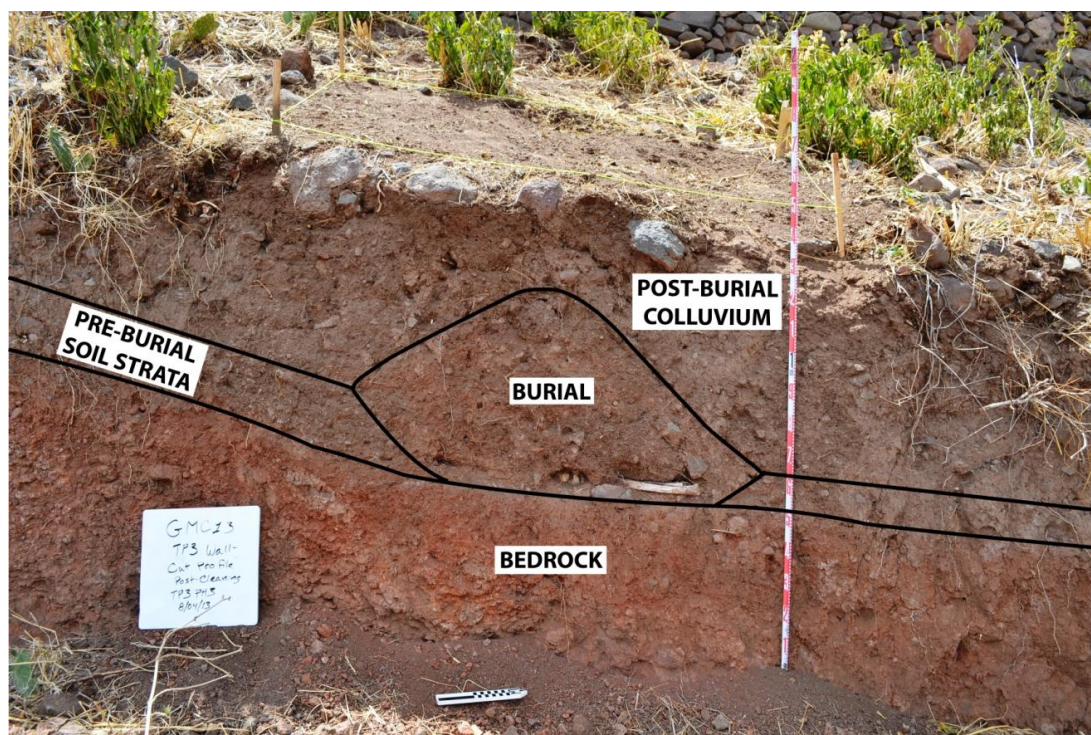


Figure 4.32. Profile cut into the hill slope during expansion of the road. The central outline shows the burial mound cut obliquely by the road cut. A tibia and fibula can be seen in the profile. Angled in the opposite direction roughly parallel to the road cut, and thus not visible here, a second, later burial truncates the top of the visible burial mound.

The superposition of these two burial features suggests that the interment of the first had been completely obscured by overburden before the burial of the second child. The burial of this second child, in turn, had been completely covered in overburden by the time we arrived at the site. Overall, this suggests the hillslope has slumped significantly, nearly exposing the burials at the slope's upper divide, and completely covering with time the burials below, to the extent that interments continued over older ones until the cemetery was abandoned and forgotten altogether.



#### 4.11. Surface collections

Here will be provided a description of the surface collections (Figures 4.33-35), the volume and type of materials found, and observations about their setting and artifact distributions. Chapter 5 will delve further into formation processes discussing relevant literature on plowzone archaeology and the effects of erosion and plowing on surface artifact movement under different conditions.

Two quantification schemes have been applied to ceramics recovered from the surface collections. To reduce discrimination bias among the collecting habits of workers, I asked that all ceramics be collected regardless of size. However, during sorting, only ceramics greater than or equal to approximately 1 cm<sup>2</sup> were retained. Retained ceramics were divided into two size classes. Only sherds greater than or equal to approximately 2 cm<sup>2</sup> were subject to multivariate recording. The smaller class of sherds were counted and weighed collectively by unit. Division of the sherds was done for a few reasons. Small sherds, having little profile for examination, posed a challenge to accurately describing things like percentage of tempers to paste. As will be discussed in the following chapter, processes like erosion and plowing also affect artifacts of different dimensions and mass differently, so dividing and recording sherds in "large" and "small" classes was an expedient means of investigating the discriminating effects of these processes in the distribution maps. Prior to analysis, the minimum dimensions for the large sherd class was set higher. As analysis began, however, it became clear too few sherds qualified for multivariate analysis and the sample size ought to be expanded as much as possible without sacrificing accuracy and good representation of the assemblage.

Ceramics made up the vast majority of material recovered from surface collections and so are most suitable to visualizing differential artifact distribution by morphological processes. Slag was common in surface collection O and lithics in collection L. Bone and lithics were also found elsewhere, though their number and density was frequently too small to visualize patterned distribution. The presence or absence of these materials will be noted here, though successive chapters will deal more directly with the quantification and analysis of these artifact classes and possible reasons for their low presence relative to ceramics.

A few surface collections are excluded from discussion here. Surface collection C was conducted near the center of the series of collections across northern Tabot Madera to create a complete transect of surface collections across the area. Collection C, however, recovered fewer than 10 ceramic fragments, and none large enough to meet standards for recording. Surface collection M did result in a large volume of material, but was only a few meters away from collection N, which was conducted in what appeared to be the same contiguous spread of surface material on Agay Midir. Collection N, however, recovered more artifacts and incorporates topographic features of interest for this thesis. Due to time constraints, then, analysis of collection N was given priority over M. Surface collection K was a small surface collection done in a field on the west side of Tarla Terrara. The area had a larger concentration of lithics than other surface collections, but no ceramics. As the only work done outside the primary study area and the only area to lack ceramics, it has little relevance to the discussion below, though it may hold value for future analysis when the lithic assemblage from Gännäta Maryam is analyzed in detail.

As with all other survey and collection methods, I took elevations with the transit at points across the surface collections and occasionally beyond them. I then used these points to extrapolate elevation contours in ArcGIS. All contours are represented in 0.15 meter increments.

During surface collections, I observed that Tringo was particularly diligent and perceptive during collections. Regularly she spotted small artifacts others overlooked and was frequently still searching for and recovering artifacts up to the six minute deadline. Other members sometimes stopped collecting before the six minutes had passed and needed encouragement to keep searching. Though they regularly appeared to collect all of the larger class of ceramics, walking past their units I sometimes noticed small sherds they had overlooked. In order to help moderate the effect of collection bias on spatial distribution in the collections, I made sure to rotate collectors to different rows every few collection periods. In some instances, however, collectors' biases are suspect in some distribution patterns and will be noted accordingly.

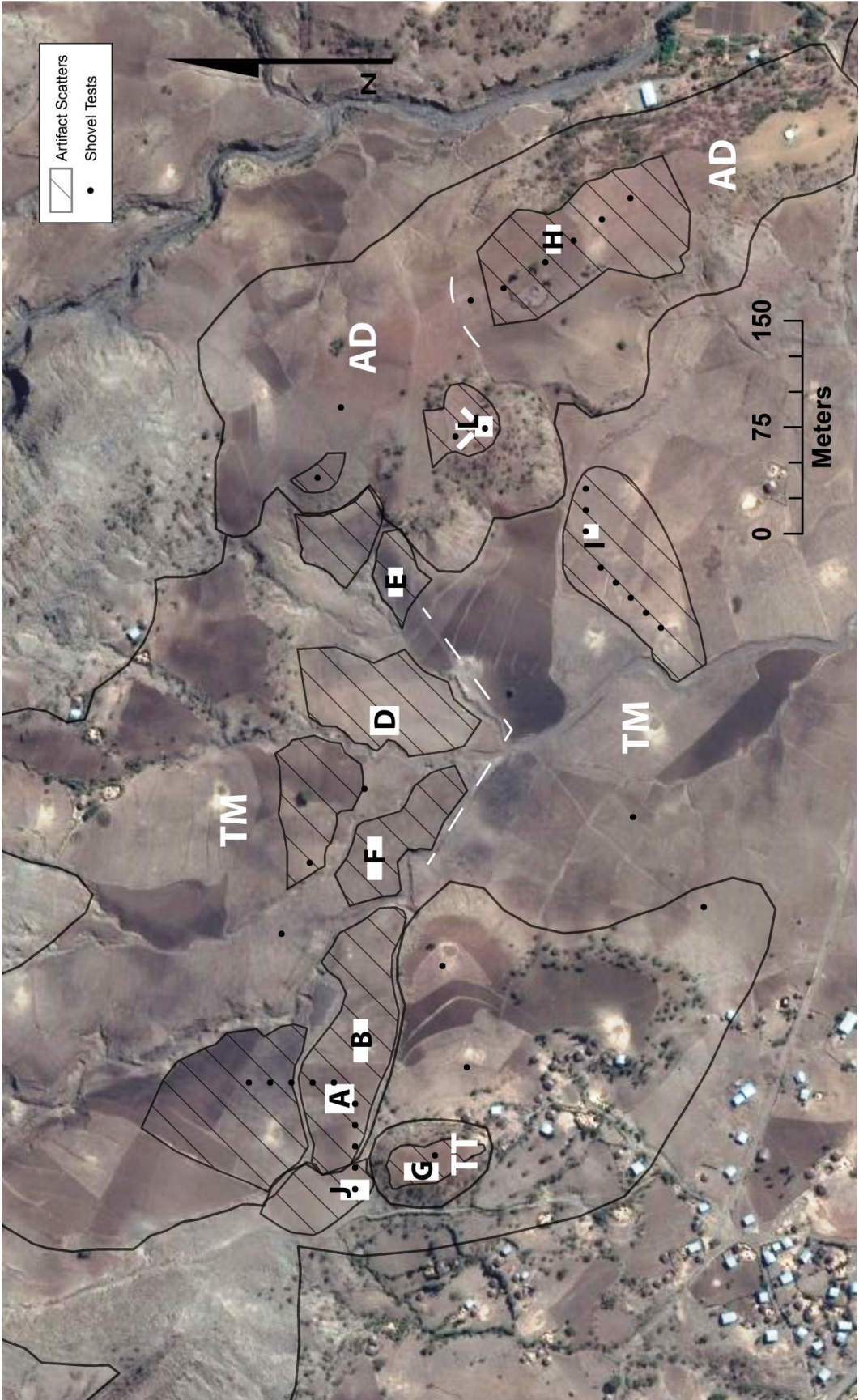


Figure 4.33. Name and location of surface collections on the lower terrace. Shovel tests shown for reference.

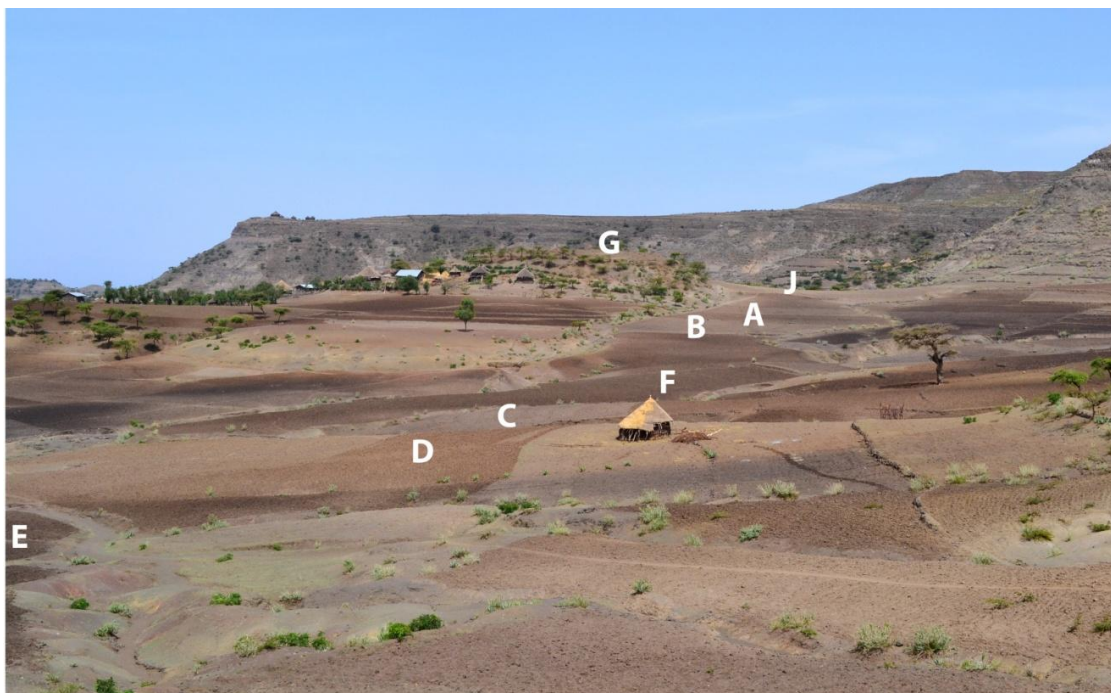


Figure 4.34. View looking west across Tabot Madera, Area A, toward Tarla Terrara hill, with the locations of surface collections approximately marked by their corresponding letters.



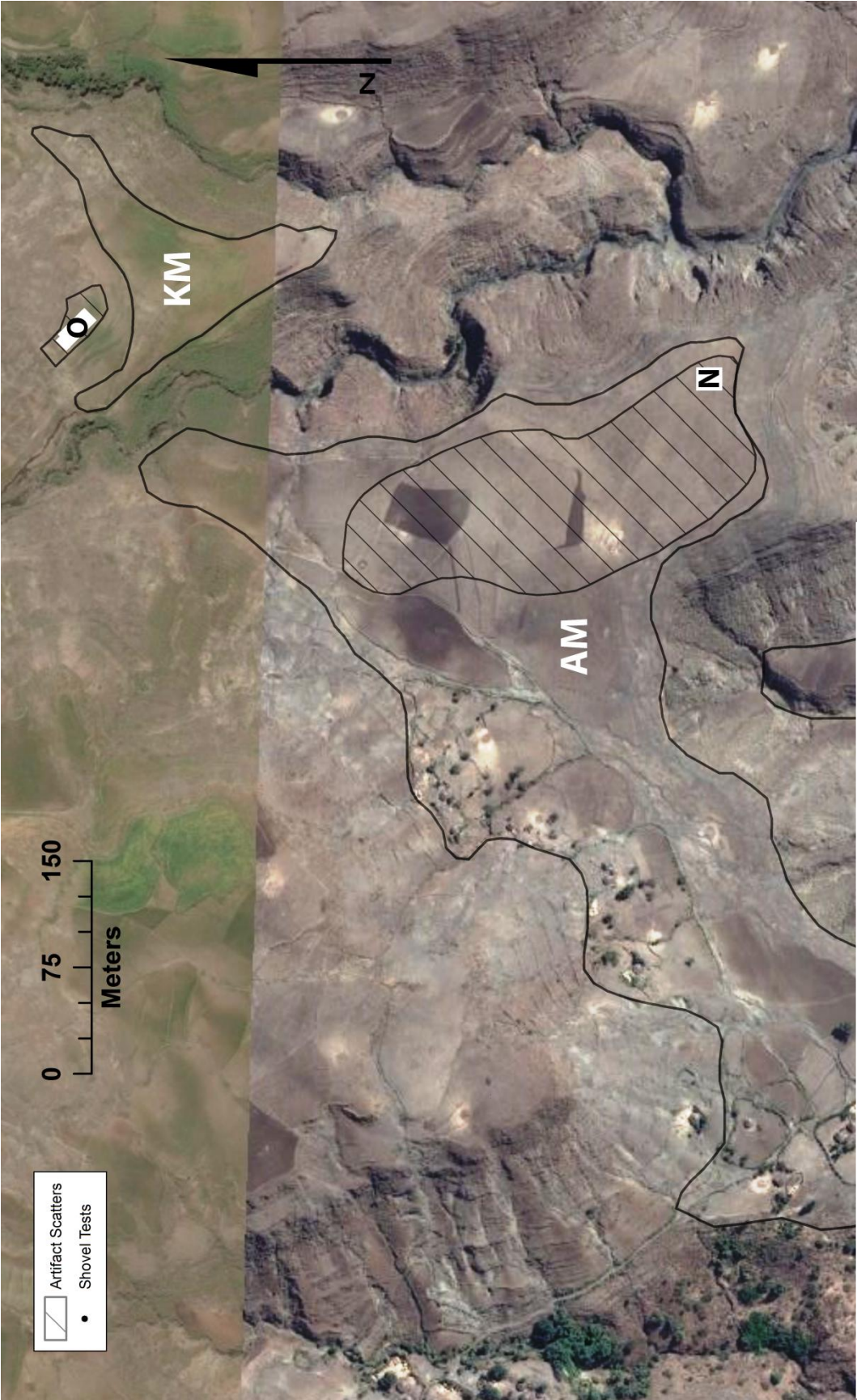


Figure 4.35. Name and location of surface collections on the upper terraces.

#### 4.11. (a) The control study: Surface collection L, Alem Doret, Area D

I begin with collection L as the site history was well known and thus can serve as a comparative study to the other surface collections. The land was occupied by a *tukul* from 1973 to 1986 according to the former resident Setegen Demele. During that time the hilltop had already been cleared of most of its forest and was under cultivation. Sometime after he abandoned the property, the *tukul* was dismantled and the land where it once stood was also brought under cultivation.

Surface collection L included four collection grids located on and around the historic abandoned *tukul* (Figures 4.33 and 4.36.). The largest collection was undertaken over the remains of the house itself, identified by the roughly 10 meter wide circular spread of stones littering the plowzone surface from the dismantling and decomposition of the structure. Three additional surface collection transects were laid out to the north, northeast and northwest of this area in order to survey artifact distribution extending away from the known historical feature.



Figure 4.36. Surface collection L, the abandoned *tukul* site, looking southeast standing over the northwest corner. The footprint of the *tukul* roughly corresponds to the concentration of stones seen in the center of the photograph.

Dimensions of the surface collections were dictated by landscape features such as acacia thickets and the hill margin. To the south an erosion control ditch has recently been created, with a bank behind it. Three collection units on the west side of the south row of the main collection grid were laid over this ditch. A unit in the main collection grid and one in the northwest transect did not contain any large ceramics, though this may be attributed the presence of trees growing out of the units occupying ground surface.

Trees and other visual obstructions prevented me from taking elevation points in some areas, particularly over the main grid and so topographic lines in the following Figures (4.37-39.) are derived mostly from the transects. This introduced a problem when extrapolating topographic lines in ArcGIS. The change and direction of slope over the main grid is exaggerated and should be slightly more level. All elevation points were taken on the grid, so topographic lines beyond the grid in the figure also inaccurately portray topography.

The field had last been plowed the previous year. Due to the small, semi-circular shape of the area, plowing was done in concentric arcs rather than straight lines as seen in the other surface collections. We excavated the shovel test in this area the previous year prior to plowing and do not expect that it has affected the artifact distribution.

Large sherds (Figure 4.37) are concentrated in the main collection area in units within the footprint of the former *tukul* and in the adjacent units. Nine of the 40 units within, intersected by or adjacent to the footprint of the *tukul* have five or more large ceramics. By contrast, in only two of the remaining 40 units were five or more large sherds collected and one of those units is the gulley, where erosive processes are expected to concentrate artifacts (see Chapter 5). In contrast, small sherds (Figure 4.38) are much more evenly distributed. The main collection grid has as many units with seven or more small sherds as the north and northwest transects combined, though the two have fewer units. Some collection bias is suspected here, however. Tringo collected the row of four units with seven to nine sherds in the middle of the main grid and I have recorded in my notes that one other collector required frequent admonishment to keep collecting after he had spent only a few minutes picking up large sherds. This may explain why some units like two in the northwest transect have 22 sherds in one unit and none in the adjacent unit.



The exception to this distribution pattern is the northeastern most blocks within the erosion gulley, which have a concentration of small ceramics in stark contrast to the lower values elsewhere. The concentration of ceramics in each unit increases down slope into the gulley. As will be explained in the following chapter, the belief is that both the slope of the terrain, alluvial transport, and the erosion of fine sediment is concentrating artifacts at the surface in these units while distribution by plowing is more significant to distributing material elsewhere across the surface collection.

Discard behavior and plowing also likely contribute to the pattern in other ways. According to Setegen Demele and the aerial images, the area of Alem Doret around his *tukul* was farmed during his residency there. He also explained that when he and his family moved off the hill, they took everything with them, including their pottery. One possible explanation for the concentration of large pottery in the middle of the site and the irregular but even dispersal of ceramics around and away from the former home might be due to discard practices and destruction from plowing. During the home's occupation, broken ceramics were reportedly casually tossed away from the home, most presumably into the plowed fields around it where they would have been gradually fragmented and dispersed by repeated contact with the plow and trampling from animals. Broken ceramic artifacts discarded in the immediate vicinity of the home meanwhile would not have been exposed to such extensive turbation for the roughly 13 years the home occupied the site, and thus may explain why they have remained more intact.

Lithics (Figure 4.39) also appear to concentrate around the former *tukul*, and to the west and northwest, though Ato Demele was not questioned regarding his use or disposal of lithic material. With such a low volume of lithics, however, differences between units may not be outside the realm of chance recovery. Despite this, the concentration is worth noting because no such concentration was noted in the other surface collections except collection H, which is believed to be an artifact distribution associated with the *nas* on Alem Doret occupied and abandoned at roughly the same time as the *tukul*. Collection L recovered lithics in over 80% of units, while collection H in over 50%. By contrast, the next highest collection rate was 34% (collection E) with an average of 17% of units with lithics among the remaining collection areas. Discussed in Chapter 5, experiments with artifact distribution in plowzones indicates that small



materials like the recovered lithics tend to sink in plow soil. The presence of a notable lithic distribution in collections L and H may be an indicator of the artifact scatters' recent origins compared to the possibly much older origins of the other artifact scatters. Note that unlike the ceramics, lithics are not concentrated in the gulley.

The *tukul* survey is important for the glimpse it provides into the disintegration of such a structure. Though it was abandoned 25 years ago and plowed much if not all of that time since then, the 10 meter diameter circle of stones is starkly visible on the landscape. Even after the reported recycling of much of the stone for fortification of the erosion bank and other purposes, the spread is not insignificant. Furthermore, after only 13 years of occupation, the combination of occupation and plowing has produced an artifact dispersal over an 18 meter or greater radius from the *tukul*'s center. Beyond the immediately vicinity of the *tukul*, this surface assemblage has a fairly even dispersal pattern, with only exceptional topographic features like the gulley concentrating artifacts.

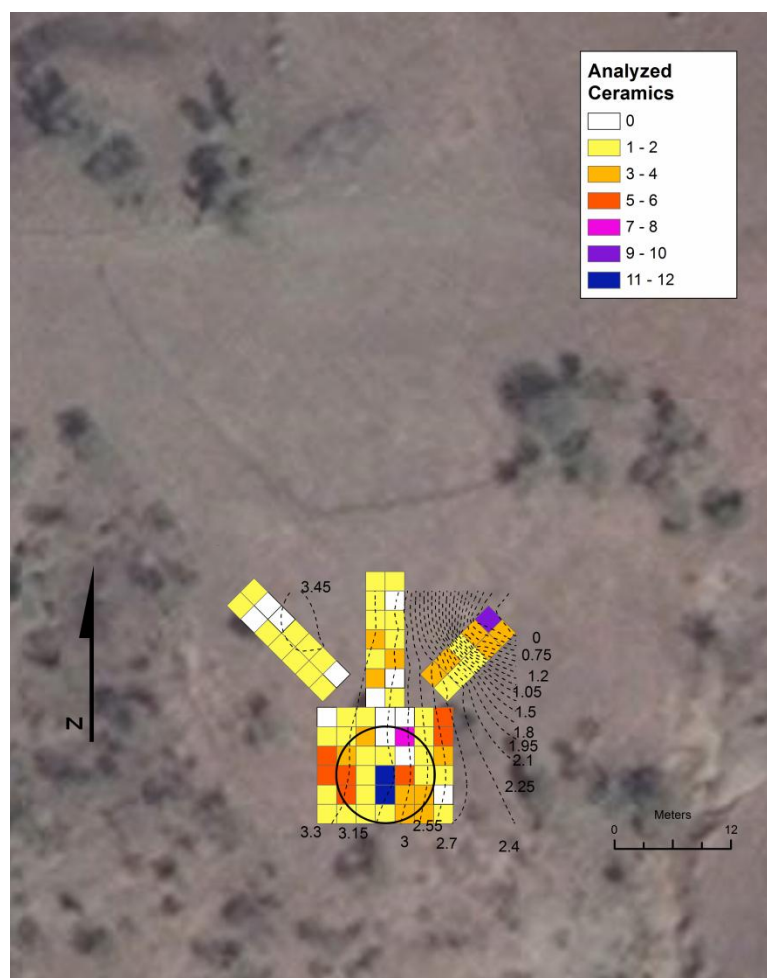


Figure 4.37. Surface collection L: distribution of large ceramics. The circle represents the footprint left by the deconstructed tukul.

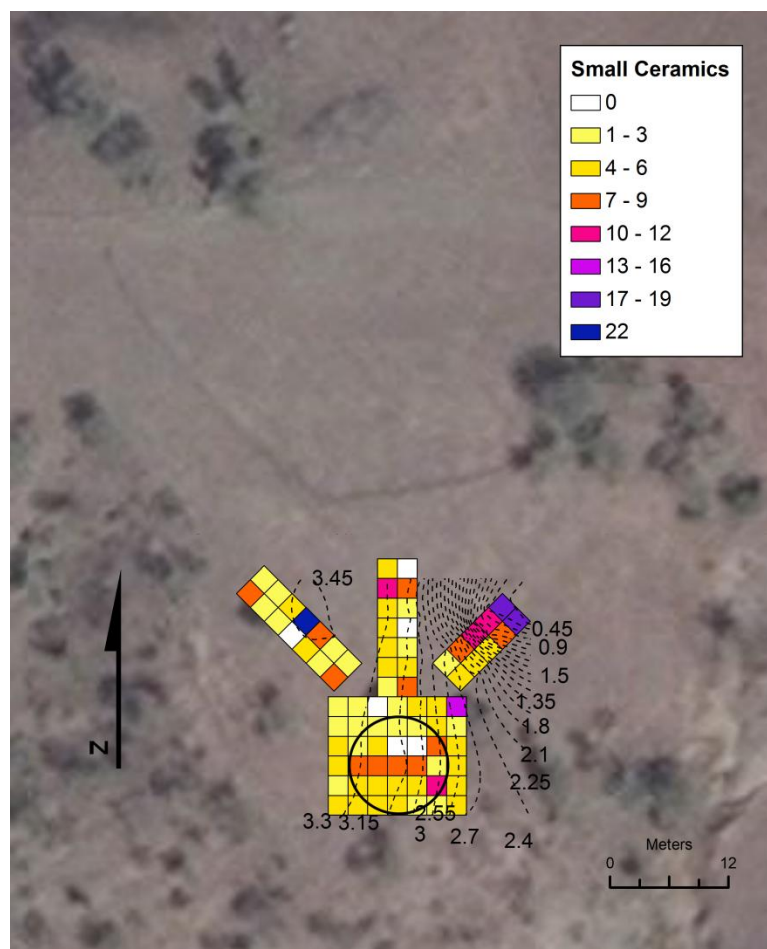


Figure 4.38. Surface collection L: distribution of small ceramics. The circle represents the footprint left by the deconstructed tukul.

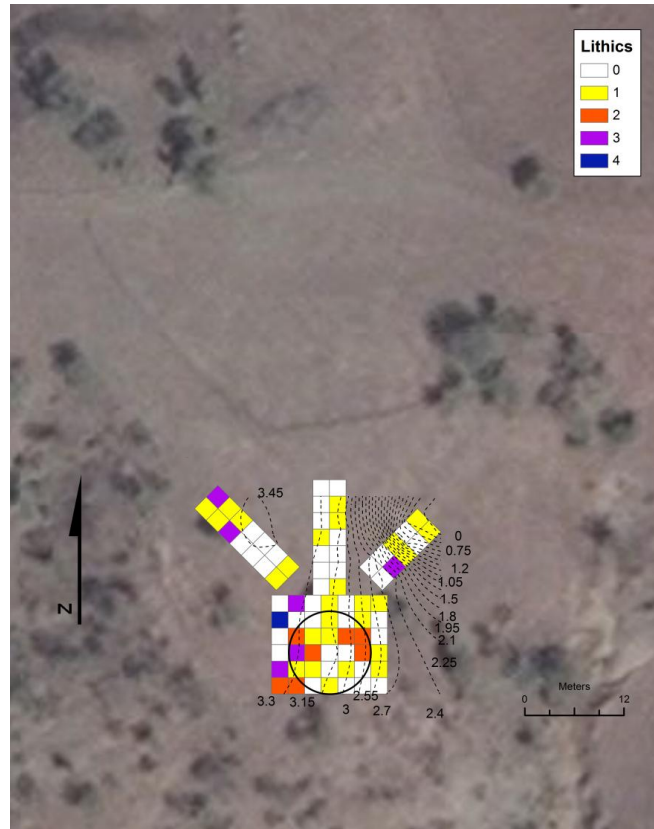


Figure 4.39. Surface collection L: Distribution of lithic artifacts. The circle represents the footprint left by the deconstructed tukul.

#### 4.11. (b) Surface collections A and B, Tabot Madera, Area A

Surface collections A and B were the first two surface collections we conducted during the first field season (Figures 4.33-34. and 4.40-42.). The grids for both were laid out on the sloping field of mostly Vertisol and vertic soil where we had conducted the first series of shovel tests. The topography of the field shows that collection A slopes east to northeast, dominated by a plowed over rill or small gulley formation visible in the topographic survey and small, relatively recent rills noted in the original field notes. Excluding the gulley feature, the slope of collection A measured in the middle of the southern half is about  $6^{\circ}$ , about  $2\text{-}3^{\circ}$  steeper than the average for the slope based on the cumulative elevations taken across the area. With a slope closer to the average of this field, collection B extends over a slight depression in the middle of the terraced field downslope (east) of collection A, just before the slope descends steeply to a large

tributary gully of the wadi. Plowing on the fields is oriented north to south, roughly aligned with the series of consecutive low packed-packed earth ridges that subdivide the slope into smaller individual fields. There appears to be a strong correlation between topography and artifact concentration.

Generally, artifact concentrations in collection A were most dense along the gully feature. This is particularly evident when looking only at the large class of sherds (Figure 4.40), where such sherds are most heavily concentrated in the northern middle and northeastern corner of the collection area, coinciding with the alluvial slope and thalweg. In fact, 84% of the units south of the topographic feature have four or fewer large sherds, while 66% of units in the northern half of the grid have five or more sherds. A row of three blocks and one tangent to the series have between seven and 14 sherds adjacent to an eastern series of units with zero to four sherds. This anomaly may be due to the low ridge of packed earth that bisects the field and collection grid, visible in the aerial image and noted during collection. The ridge perhaps retains some material behind while plowing and erosion on the lower side move artifacts away.

A similar pattern is expressed when the small class of sherds are mapped (Figure 4.41). Of 18 units with 25 small sherds or more, only two are located in the southern half of the grid. The highest concentration of sherds remains around the alluvial feature, though the concentration is more evenly distributed over the lowest elevations east of the earthen ridge.

Surface collection B shows a different pattern related to its unique topography. The collection block crosses over another small ridge of packed soil in its western section, identical to that bisecting collection A. A small depression lays down slope of earthen ridge, before the surface rises again slightly. Immediately beyond the collection block to the east, the ground descends steeply and surface artifacts were no longer visible.

Examining only analyzed ceramics (Figure 4.40), the concentration of ceramic sherds is clearly greatest west of the low rise in elevation to the east. Likewise, a similar pattern is noted among the small class of sherds. Further inference from this artifact distribution is complicated by noted collection bias during work here. Collection B was the first surface collection with Tringo's assistance and rotation among collectors was not yet done. The continuous presence of artifacts in the southern column and column

second in from the east were both her rows and artifacts appear in greater numbers there than in adjacent units. Though collection methods were explained, I believe she did not initially understand the importance of only taking artifacts from the surface and not from poking through the soil until near the end of this collection.

The bias appears to be moderated by mapping the distribution of the sum of both small and large ceramics. Once done, it appears that ceramic artifacts in general are most densely concentrated west of the earthen ridge and concentration declines moving west. In all likelihood, the earthen ridge in this unit favorably retains ceramics behind it similar to what was observed in collection A. Erosion and north-south plowing do not move artifacts past the depression and over the slight rise to the east, leaving most ceramic sherds to the west.

Lithics were recovered in 32% of units from collection A and 27% of units from collection B. Density was low, however. In all but five units, only one lithic was recovered, the remaining all having two. A large grinding stone fragment was also found in collection A. Two fragments of sheep, goat or cow tooth enamel and a piece of very eroded bone were also recovered in the surface collections. As discussed in the faunal analysis section of Chapter 6, however, these fragments are likely to have come from recent animal activities rather than disturbed archaeological deposits.

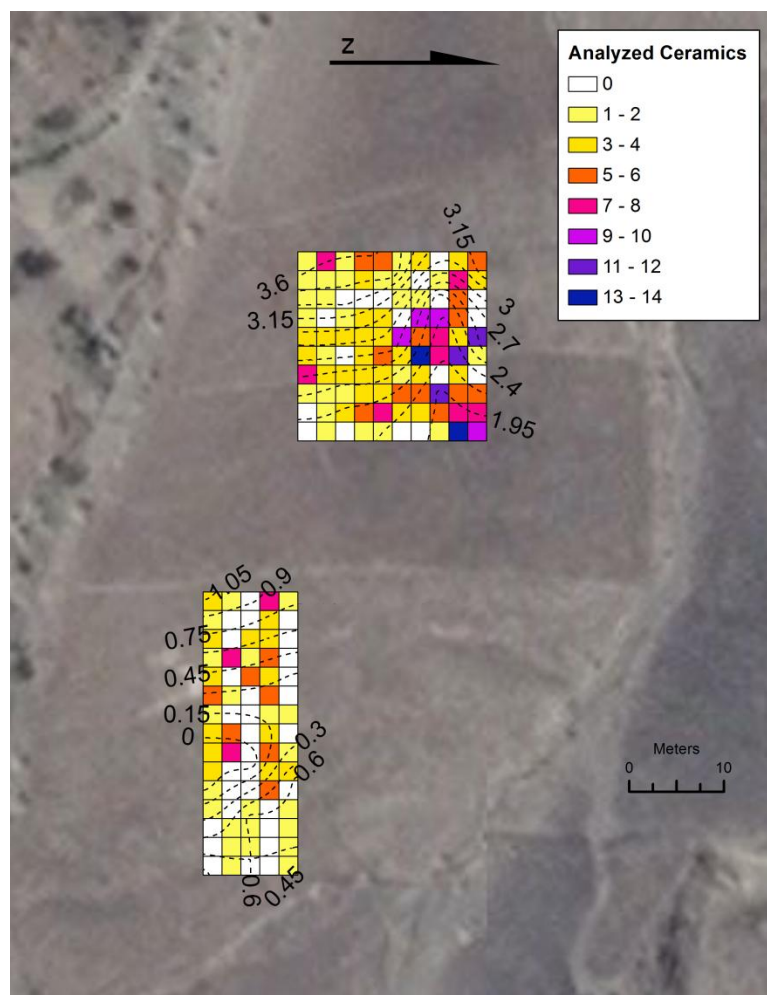


Figure 4.40. Surface collections A and B, Tabot Madera, Area A: distribution of large ceramics.

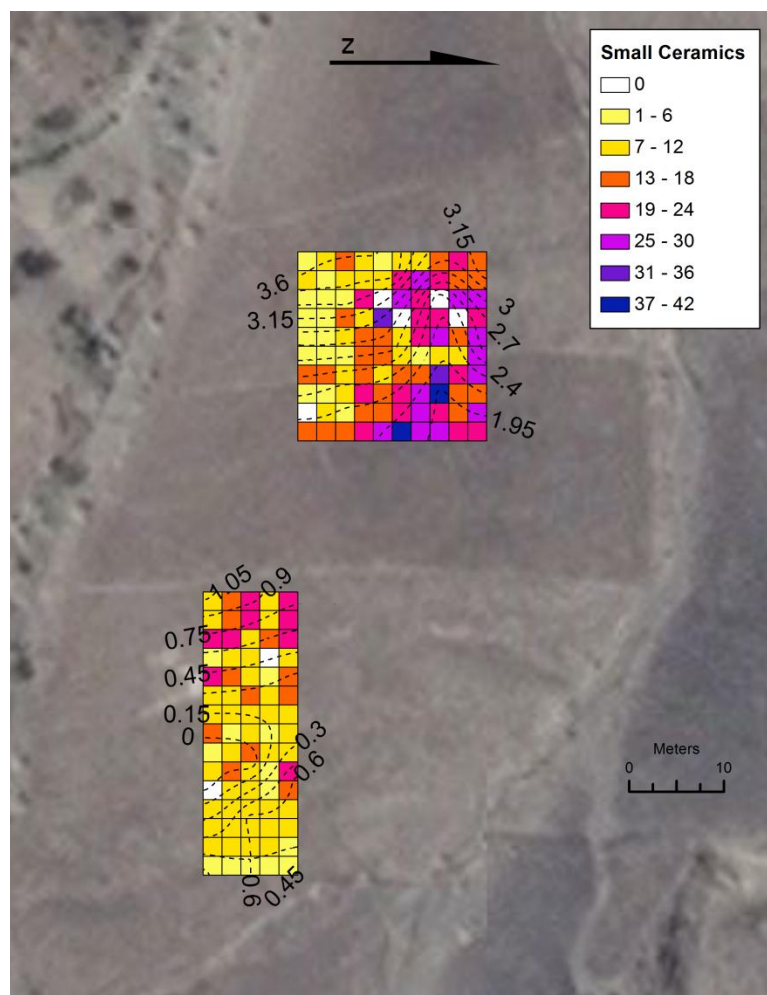


Figure 4.41. Surface collections A and B, Tabot Madera, Area A: distribution of small ceramics.



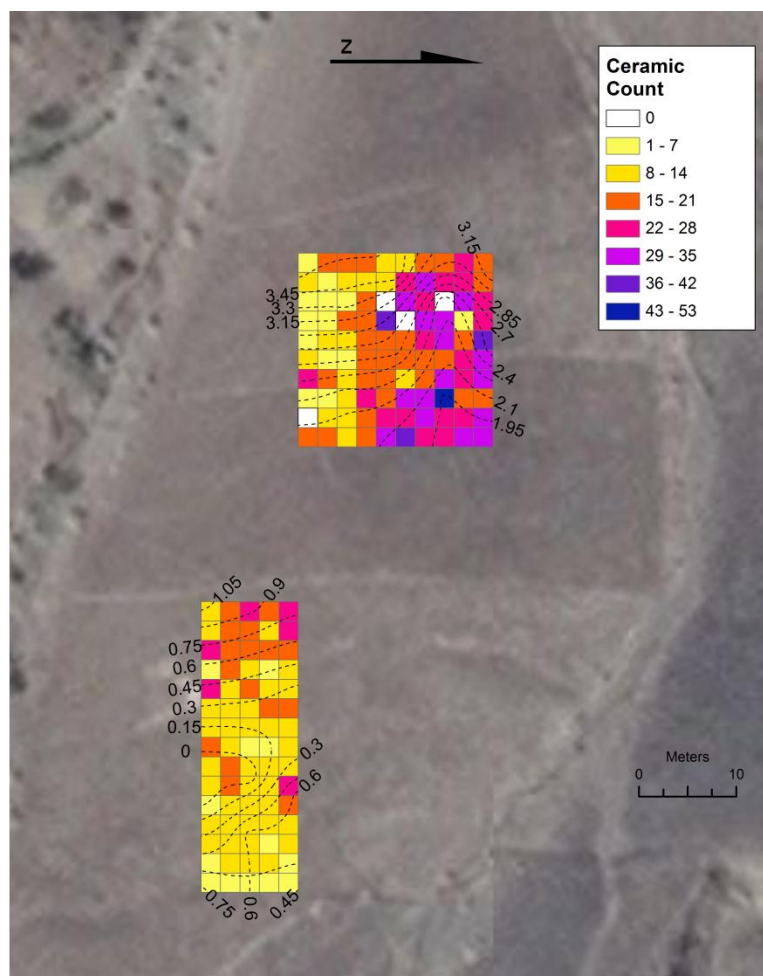


Figure 4.42. Surface collections A and B, Tabot Madera, Area A: distribution of all ceramics.

#### 4.11. (c) Surface Collection D, Tabot Madera, Area A

Only 28 sherds were recovered from surface collection D (Figures 4.33-34 and 4.43). Unlike other surface collections, large sherds outnumbered small sherds by a ratio of 5:2. This makes it the highest ratio of large sherds to small sherds in any collection. However, out of 100 units, it is also the lowest concentrations of artifacts in a collection grid. The area around the collection grid had an average slope of about 5°, though the grid itself was placed over the head of a slight depression, the head of which is a steeper 10° descending to a more moderate 5°. The slope was a dusty, pale colored soil that had

not been plowed during the collection season, though plow scars showed it was done in a roughly east-west direction perpendicular to the slope.

Because of the small number of ceramics retrieved, artifact distribution patterns are best represented by displaying all sherds. Artifacts cluster around the head of the depression, where undercutting on the slope may be concentrating them. Likewise, there is also a lesser concentration on the flatter area below the steep slope. With such a small volume of recovered material, however, this distribution may be coincidental rather than influenced by topography. The dearth of small ceramics is notable, and may be a result of erosion selectively removing lighter artifacts.

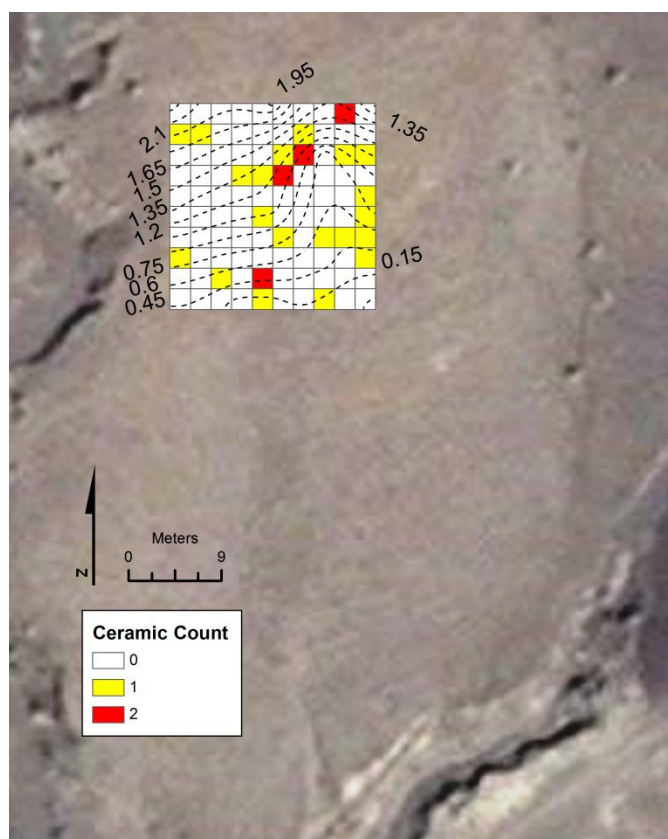


Figure 4.43. Surface collection D, Tabot Madera, Area A: distribution of all ceramics.

#### **4.11. (d) Surface collection E, Tabot Madera, Area A**

Surface collection E (Figures 4.33-34 and 4.44-45), like collections A and B was placed on Vertisol soil. In this instance, however, the placement was a small spit of land circumscribed by a gulley to the north, Alem Doret to the east, and a talus of the hill projecting near the south. A footpath runs close to the collection leading up to Alem Doret. While artifact density was low relative to other collections on Tabot Madera like collections A and B, the ceramic analysis in Chapter 6 will discuss the large concentration of Fine Red Ware sherds recovered here which are rare in other collection areas. Thirty-four percent of units also contained a single lithic, the highest recovery rate after collections L and H.

The majority of the grid slopes southwest at an angle of about  $4.3^{\circ}$ , though there is a sharp rise in the northeast corner. Analyzed ceramics appear to be evenly distributed across the surface. Smaller ceramics, however, are more densely concentrated in the southwest corner at the lowest elevations. The first 45 cm of rise in the slope, for example, comprising  $\frac{1}{3}$  of the surface collection area, contains 75% of the units with five or more small ceramics. The number of ceramics per any given unit is small, so it may be unwise to draw too many conclusions from this distribution, particularly when the original locus of deposition is unknown. However, this unit continues to fit the trend observed in other units and discussed in the following chapter of smaller sherds disproportionately concentrating at lower elevations on surfaces with slopes greater than  $4^{\circ}$ .

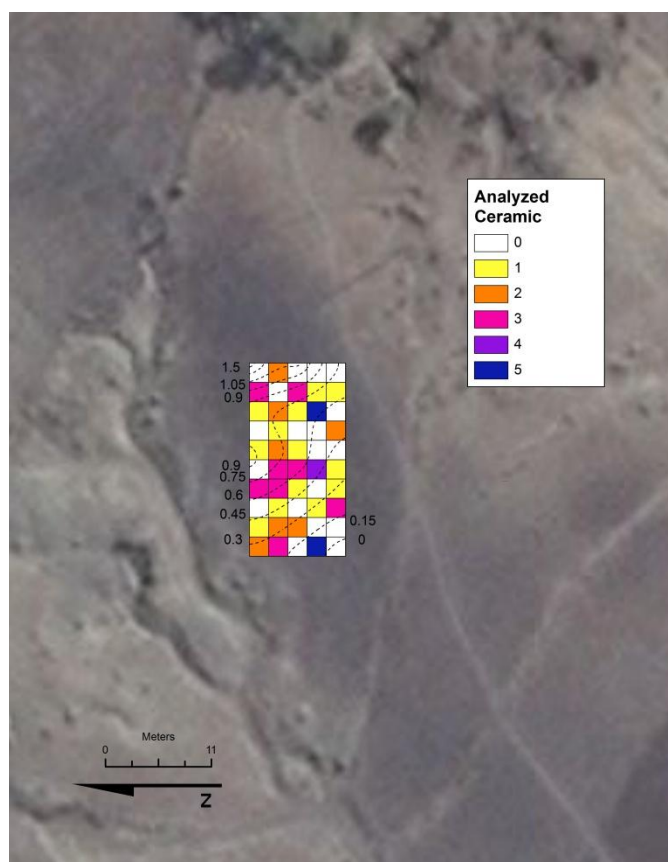


Figure 4.44. Surface collection E, Tabot Madera, Area A: distribution of large ceramics.

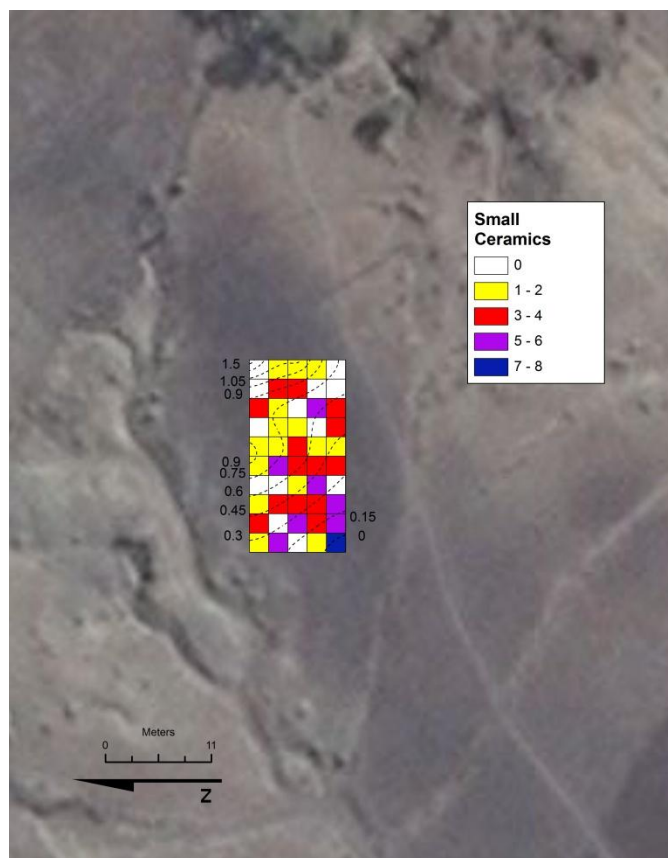


Figure 4.45. Surface collection E, Tabot Madera, Area A: distribution of small ceramics.

#### 4.11. (e) Surface collection F, Tabot Madera, Area A

Compared to the previous three surface collections in the upper half of Tabot Madera, Area A, we conducted collection F (Figure 4.33-34 and 4.46) on a relatively flat, terraced field extending between two deep gullies, with a maximum slope angle of  $2.3^{\circ}$  and less across most of its surface. There were very few artifacts recovered in this area per unit, but their distribution appears even. The even distribution of material on such a level surface suggests erosion likely plays little role in artifact movement here and plowing is probably the only relevant factor to consider.



Figure 4.46. Surface collection F, Tabot Madera, Area A: distribution of all ceramics.

#### 4.11. (f) Surface collection G, Tarla Terrara

Collection G (Figures 4.47-48) was conducted on the top of Tarla Terrara Hill. The center of the surface collection was fairly flat but descends by an angle of about  $4.5^\circ$  near the corners of the collection block in all but the southeast corner. This central flat area was characterized by numerous small exposures of bedrock and a slight concentration of small *Acacia* bushes hugging the ground, usually one to two feet wide and tall. Plow scars show that the last plowing event following a north-south path along the long axis of the hilltop. Despite the fairly level surface over much of the area, large ceramics have a notably low concentration in the central area of the collection grid. Units

with zero to one large sherd are disproportionately concentrated at the highest central elevation with larger concentrations existing only in units along the margin of the highest contour. Large sherds appear to concentrate instead along the peripheries of the collection grid at lower elevations. Small ceramics, by contrast, are more equitably distributed. Lithics were also equitably distributed among 28% of the collection units.

A few factors may contribute to the paucity of large ceramics in the central area compared to small ceramics. Plowing, for example, is reported to disproportionately move larger artifacts than smaller ones, often with a net down slope movement (see discussion in chapter 5). This may contribute to gradually moving large artifacts away from the apex of the hill towards its sloping margins. Likewise, the apex of the hill is also a likely place to receive a disproportionate degree of foot traffic by grazing animals and humans as they cross back and forth, trampling ceramics and reducing their size. Acacia scrub was mapped during the survey, and the highest concentration is also in the area of highest elevation. Possibly, the presence of the thorny scrub deterred a more thorough investigation of surface artifact contents introducing human bias to the collection as well.

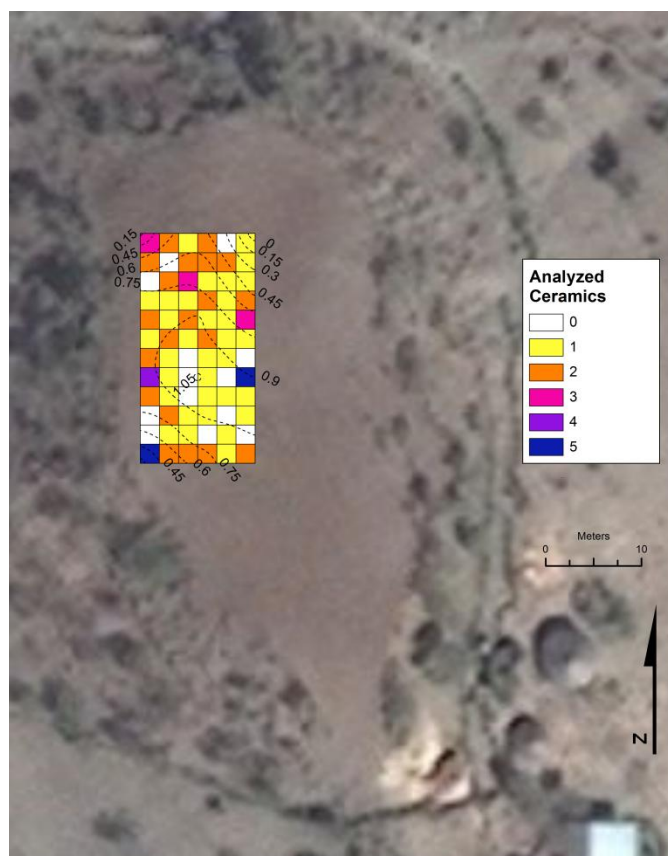
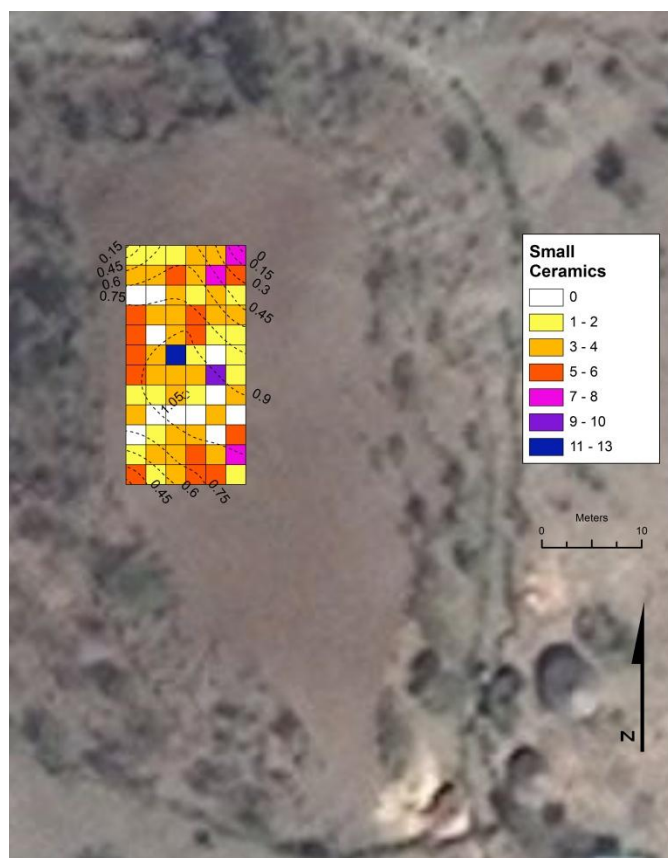


Figure 4.47. Surface collection G, Tarla Terraza: distribution of large ceramics.





4.48. Surface collection G, Tarla Terrara: distribution of small ceramics.

#### 4.11. (g) Surface collection H, Alem Doret

Surface collection H (Figures 4.33 and 4.49-50) was also conducted on a relatively flat hilltop, the difference in elevation being the smallest of any surface collection, only 25 cm between the northwestern and southwestern corners. The western edge is near an abandoned *nas*, and may contribute to the slight concentration of large and total ceramic sherds found in the western, and primarily southwestern area of the collection. However, it is worth noting that a number of footpaths cross through the collection area. Those drawn in the original collection map differ from those captured in the satellite image, suggesting that with each successive plowing season, new paths are trodden through the area. We also frequently observed herds of goats and sheep grazing on stubble in the area and being driven across the hill. Foot traffic on each path is likely to kick away ceramics, while trampling by humans and animals generally contributes to

their further diminution. Because the paths are changeable, however, the combination of plowing and human and animal action likely has a stochastic effect on artifact distribution. With no great change in elevation, erosion is expected to play little if any role in artifact movement, and so the relatively even distribution of both large and small ceramics across the surface is expected. Surface collection G also had the second largest concentration of lithics after collection L, with 58% of units containing at least one lithic, in four instances two to three.

The second highest row of units with only one to two large ceramics appears to be an anomaly compared to its neighboring units. I strongly suspect collection bias by collectors as there is no other clear reason for this regular though unexpected pattern. The past existence of a previous feature like a well-used path from the nas that might contribute to preferential artifact distribution is an unlikely cause since plowing and subsequent foot traffic would likely negate the effects of earlier sorting processes. Furthermore, the regularity of the pattern across a two meter wide swath seems difficult to square with natural processes that would not be beholden to such geometric constraints.

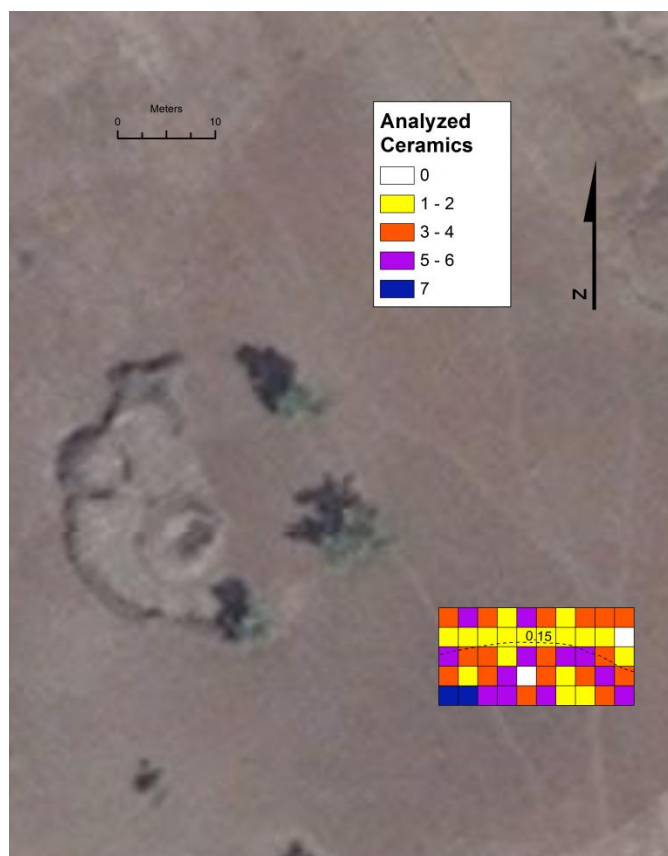


Figure 4.49. Surface collection H, Alem Doret: distribution of large ceramics.

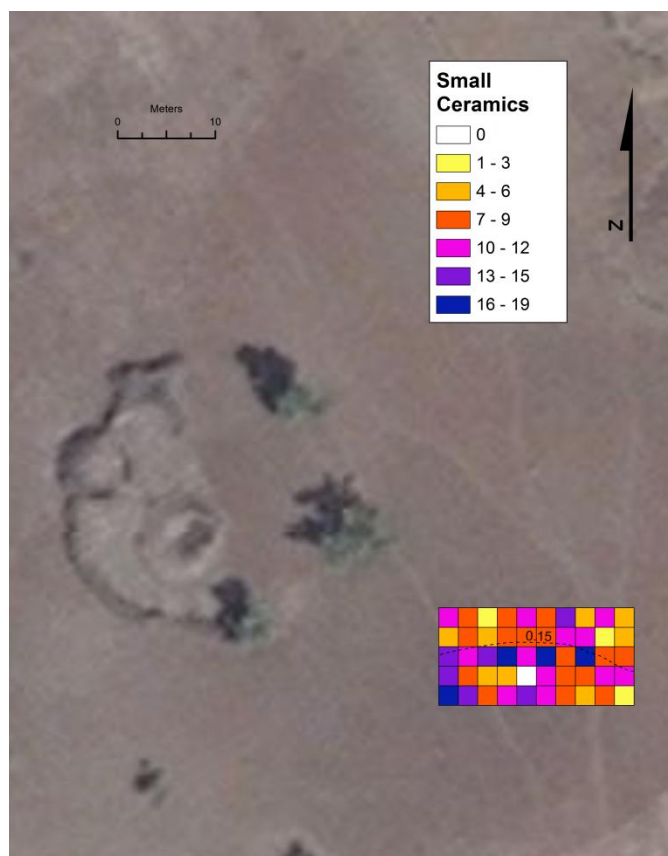


Figure 4.50. Surface collection H, Alem Doret: distribution of small ceramics.

#### 4.11. (h) Surface collection I, Tabot Madera, Area C

Surface collection I (Figures 4.33 and 4.51-4.52) was rather small due to ongoing plowing in the area that prevented us from extending the unit further. Like collections F and H, the gradient here was rather low, about  $2.25^\circ$ . Larger artifacts appear evenly distributed, while smaller artifacts may be concentrated slightly at the lower elevation. With the small collection grid size, however, correlating distribution to slope may be misleading - a result of collectors' bias or coincidence. Another source of error may have come from the shovel tests conducted in this area, which took place in the middle of the central block in the northernmost row. A fan of alluvial sand and gravel washed from Alem Doret was observed in this field, however. With enough overland flow descending the slope, the flow might have enough energy to gradually sort smaller artifacts from larger, despite the low slope angle.

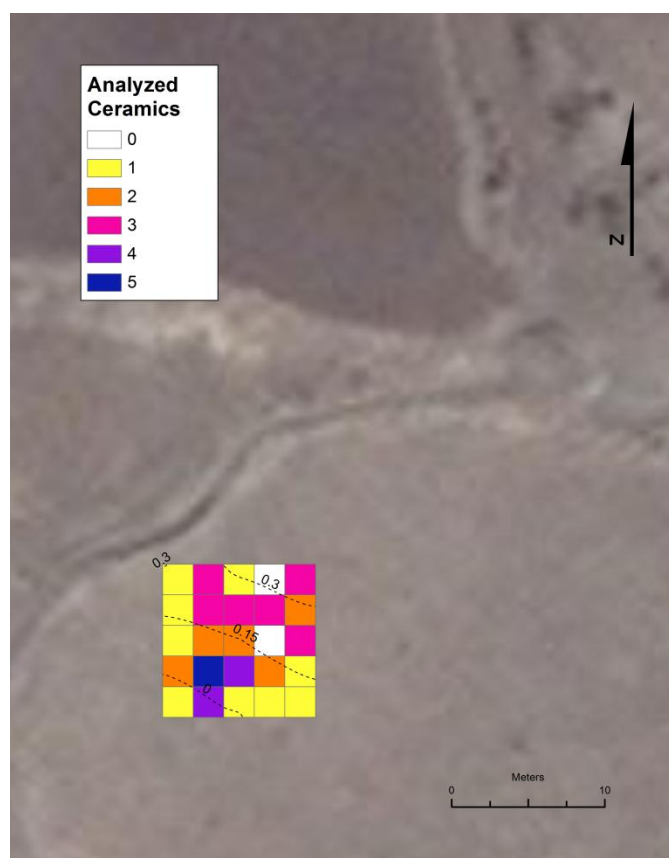


Figure 4.51. Surface collection I, Tabot Madera, Area C: distribution of analyzed ceramics.

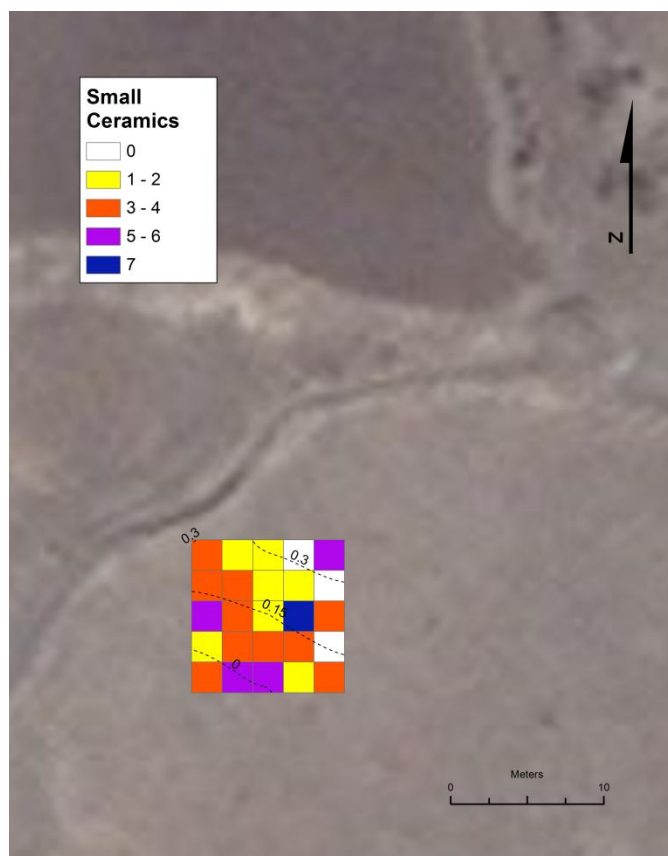


Figure 4.52. Surface collection I, Tabot Madera, Area C: distribution of small ceramics.

#### 4.11. (i) Surface collection J, Tabot Madera, Area A

We conducted surface collection J (Figures 4.33 and 4.53-54) over the saddle previously shovel tested as part of the Tabot Madera, Area A shovel test radii, and which serves as the nexus point between paths to and from many parts of the study area. The saddle was heavily eroded and compacted by foot traffic, particularly along its midline where artifacts were absent. Bedrock was also exposed along the southeastern edge. Despite heavy traffic and presumably thin soil in the area, north-south oriented plow scars demonstrate attempts to cultivate the area during a previous season. Visible from the ground and in the topographic lines, an old and rounded out gulley head has produced a depression in the northeastern end of the collection grid where the saddle dips and transitions to the lower field (see Figure 5.6 in the following chapter).

Artifact distribution in the area is unique, and challenging to explain. Artifacts were heavily concentrated along the southeast and northwest margins of the collection area, particularly in the former. Examining the topography, it appears artifacts concentrate in the most level areas. The gulley, for example, is devoid of artifacts except for one unit in a small cleft at its head. That artifacts would concentrate in the cleft of such erosion features was already noted in collections A and L, however here the concentration is isolated to one unit. Artifacts are also absent in the southwest corner where the area is largely exposed bedrock. Likely, without the protection of soil, any artifact that was ever deposited here was severely prone to erosion. Paths cross the northwest corner of the grid in the original surface collection map, but appear to have little effect on artifact concentration contrary to the expectation that paths would fragment or disperse sherds. However, periodic plowing perhaps helps to redistribute artifacts back into such paths. Accidental breakage of vessels carried by residents along paths may also contribute to their concentration. The strongest concentration of artifacts, in the southeast, is perhaps attributable to the slope of Tarla Terrara. A path was noticed tracing the lower margin of Tarla Terrara during fieldwork and is partially visible in Figures 5.5-6 in the following chapter. Numerous sherds were entrenched in the profile and likely erode out and downslope.

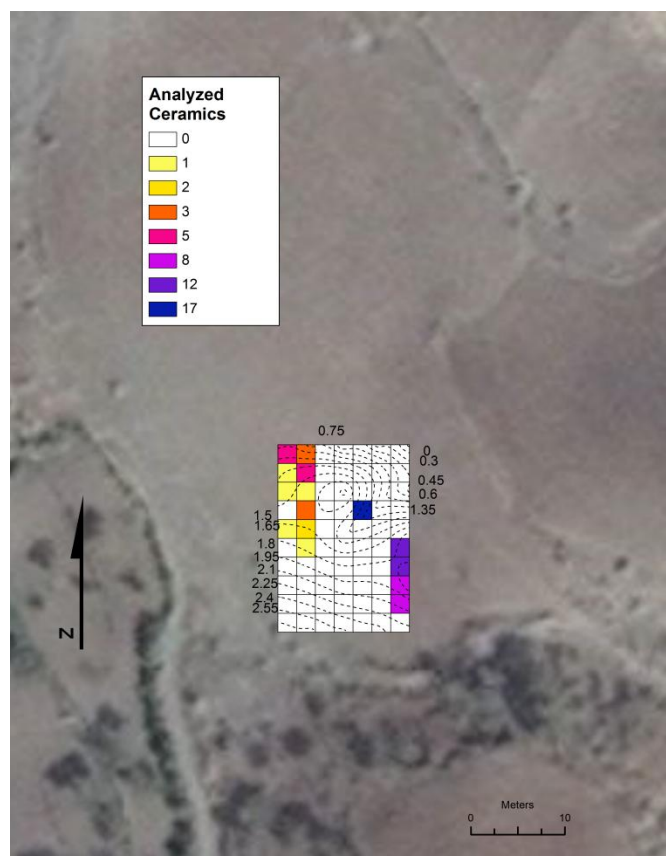


Figure 4.53. Surface collection J, Tabot Madera, Area A: distribution of large ceramics.



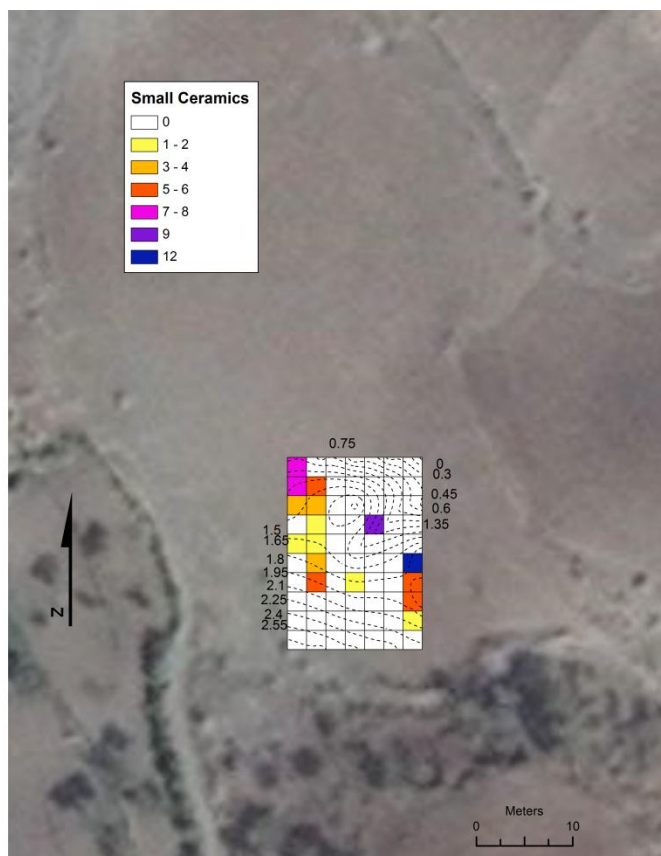


Figure 4.54. Surface collection J, Tabot Madera, Area A: distribution of small ceramics.

#### 4.11. (j) Surface collection N, Agay Midir

I placed surface collection N (Figures 4.35 and 4.55-56.) at the southeastern corner of the terrace of Agay Midir. The majority of the surface collection covered the field of rocky cambic soil, while the southern margin crossed over an exposure of bedrock and perhaps intentionally placed stones, buffering the field from the terrace edge. The terrace edge is a lower-lying area of lithic Leptosol traversed by a footpath from east to west.

Interpolation by ArcMap of survey elevation points do not represent this rock outcrop precisely, rendering it as a tightly packed series of topographic lines instead of the more rocky surface and edge it is. Though this could not be corrected in ArcGIS, it does not appear to significantly affect analysis. Both field and terrace margin descend to

the southwest at an average of about  $3.75^{\circ}$ . The field had not been plowed yet this season, but relict furrows show plowing was done east-west.

Artifacts are sparse in the northeast corner of the collection area, at the highest elevation. Large ceramics are concentrated along the western and southern portions of the study area where units regularly have as much as twice the volume of sherds as in the northeast quadrant. Large artifact concentrations are particularly notable around the rock outcrop bounding the field, possibly aggregated there by plowing or erosion and captured by the rocks from further movement. Small ceramics are also strongly concentrated around the rocks like large ceramics, but are less prevalent to the northwest. Combined, the two prove a very large concentration of ceramics in the southwest around the rock outcrop, often more than twice the volume of sherds in the opposite corner. In each case, the second row from the bottom (south) has a slightly lesser volume of ceramics than those rows above and below it. This is likely due to the footpath that runs through these units, where traffic is likely to crush or kick away ceramics and where movement by alluvial forces is likely strongest.

The discrepancy of larger sherds concentrating generally around the western margin of the grid and small sherds to the southwest may be due to a combination of original *in situ* deposition and differential erosion. Overall, the relationship between topography and artifact placement does appear to show a strong correlation between artifact concentration and lower elevation, the rock outcrops also serving to capture artifacts against further erosion. However, the unit was placed at the southwestern end of a much larger artifact distribution and so the original locus of deposition may also have been concentrated to the west. Again, erosion on slopes like this are likely contributing to a concentration of smaller artifacts down slope and the rock outcrop probably plays a role in capturing and retaining artifacts, but the overall pattern is probably also a result of the collection grid's placement relative the terrace and field, with the center of the original locus of deposition being somewhere west of the grid.

Lithics were also found in appreciable number in this collection grid. Twenty-five percent of units contained one to three lithics, mostly concentrated around the rocks. This is higher than the average for the collection grids.

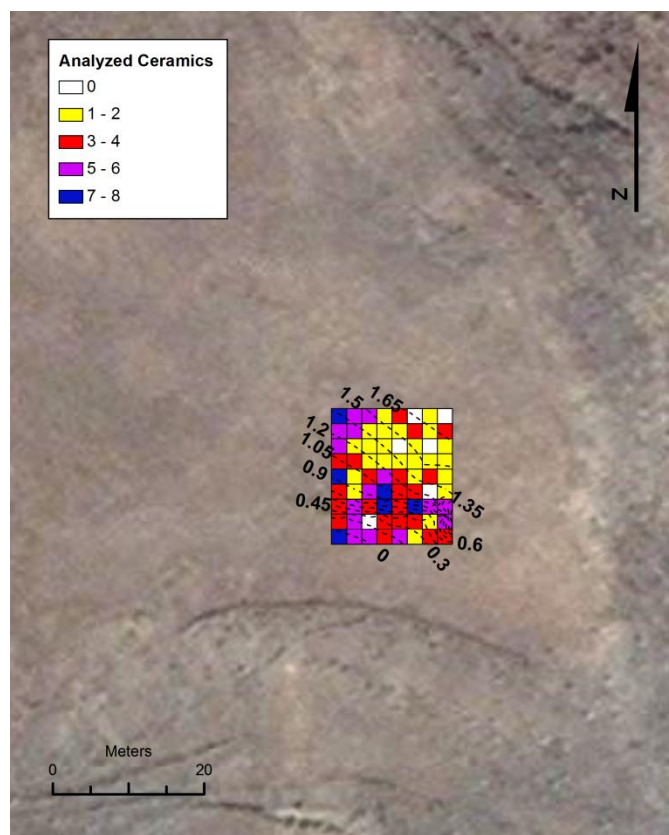


Figure 4.55. Surface collection N, Agay Midir: distribution of large ceramics.

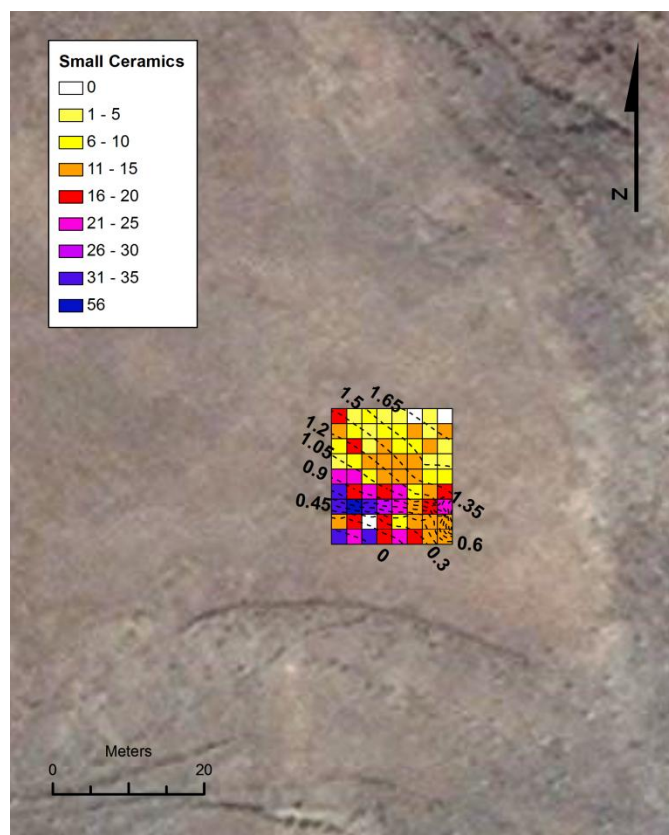


Figure 4.56. Surface collection N, Agay Midir: distribution of small ceramics.

#### 4.11. (k) Surface collection O, Kiflie Mado

We placed surface collection O (Figures 4.35 and 4.57-58) at Kiflie Mado to sample the field where slag and ceramics were common on the surface. The distribution of slag was tightly circumscribed by the exposed bedrock above the field, gullies to either side, and a recently constructed ditch and wall down slope. Due to time constraints and challenging access to this area, I did not set up the transit to take elevations along this grid. Because of time constraints and the volume of the assemblage of ceramics from this collection and the associated units, I also did not segregate the sherds into a large and small class. Rather, I only did multivariate recording on sherds with features like diagnostic profiles, decorated sherds, and rim sherds. Thus the distribution map below shows the net collection of sherds from the area, rather than two maps showing the distribution of large and small sherds, respectively.

The upper half of the area where excavation Unit 7 was later placed has a grade of about 5-8° based on the excavation there and rough measurements done in the field without the benefit of the transit. About midway through the slope of the field, the bedrock is exposed at the surface in isolated patches across the eastern half of the collection area. Below this area, the field angles steeply to about 15°, though the slope here might be slightly exaggerated by the construction of the wall, which removed soil from the field's edge to pile up into the wall, creating a negative space the field will eventually erode to fill (Figure 4.57). In the western half of the collection area, the rock does not outcrop, but instead a small depression in the land was visible, as if a gulley or rills form here between plowing.



Figure 4.57. Location of surface collection O, "the slag site" at Kiflie Mado. Trench in bottom left was dug for the stone and earth bund. Note the bedrock outcrop in the upper right, dividing the field into an upper and lower half, and the slight depression beyond the outcrops defining the western end of the collection area. Recently built stone lynchets, part of the local food-for-work project, are visible in the background.

Even without the benefit of topographic lines, surface collection O shows most clearly the movement of ceramic artifacts by erosion. The rock outcrops that define the

middle of the field and change in slope run through the middle two rows of the collection unit. Sherd density up slope of this line is regularly half or less of the artifact concentration seen below the outcrop. In the eroding depression to the western end of the field, artifact distribution is a little more even up and down slope though still as strongly concentrated down slope as the rest of lower elevation.

Slag was collected from 15 units, often highly concentrated with an average of four pieces of slag per unit and as much as 16 pieces in one instance. Mapped, the number of units is insufficient to identify a pattern. Units with slag are in every area of the map. In all but one instance, slag co-occurs in units with ceramic sherds.

Only four lithics were recovered from the surface collection, putting it on par with collection D for lithic density of about 4.5% of units. Recalling that collection D had only 28 ceramic sherds, however, puts into perspective the low density of lithics recovered here. If the area was occupied by a blacksmith/potter family, as seems likely, the family would have had little if any need for lithic tools given their access to metal tools, explaining the minor presence of lithics.

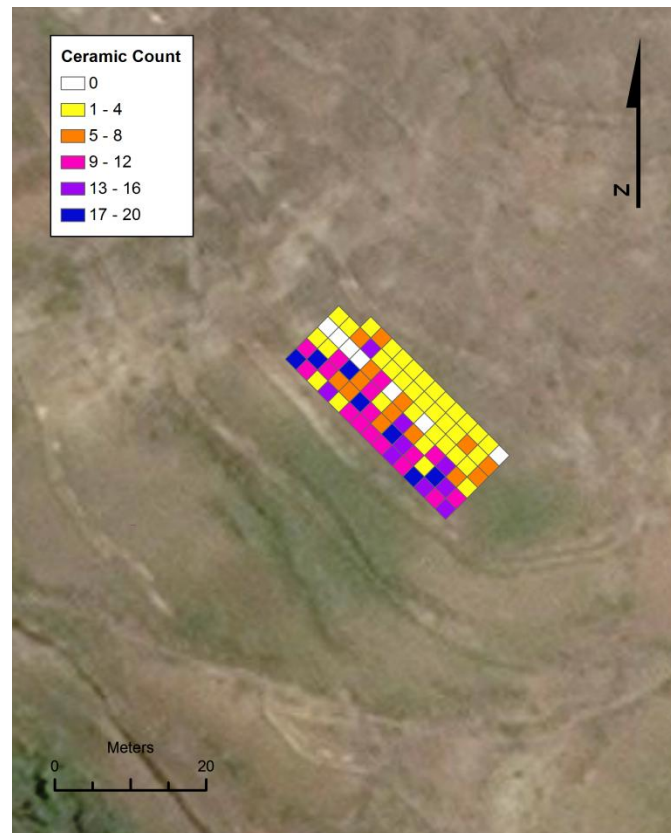


Figure 4.58. Surface collection O, Kiflie Mado: distribution of all ceramics.

#### 4.12. Conclusion

Research at Gännäta Maryam began as an investigation of a supposed royal or specialized community evidenced by the large scatters of artifacts in the study area and the supported by history and oral tradition. Immediately after fieldwork began, however, the project changed its focus to studying archaeological formation processes. To this end, a variety of research methods were employed to understand the local geomorphology and their affects on archaeological contexts. Meanwhile, attempts were made to collect enough archaeological data to at least intimate what kinds of people or activities may have produced the now heavily disturbed archaeological remains seen in the area.

Oral history was collected from residents and combined with comparable ethnographic data. Conclusions drawn from this research were further supported by

historical aerial imagery. Together the two helped to produce a picture of landscape and land use states and changes over the past half century or more. The impression created is one of an environment that came under increasingly heavy exploitation, exacerbating erosion. Recent behavioral and land use patterns are beginning to reverse the worst trends and practices of the past, but are likely too little and too late to preserve archaeological remains intact.

We excavated shovel tests across much of the lower terrace. Three sets of divergent transects were placed in areas with noted surface artifact densities and proved that the presence of surface artifacts in plowzones rarely indicate the presence of subsurface archaeological contexts. We placed thirteen additional shovel tests across Tabot Madera and the hills of Tarla Terrara and Alem Doret. These shovel tests confirmed the previous results, but more importantly, provided stratigraphic and pedological data necessary to produce soil and geological maps of the area for comparison with artifact and archaeological context patterns.

In the few instances where subsurface contexts were believed to possibly exist, we conducted excavations there. Of nine total excavations, including the joint project at the Church cemetery, four revealed well-preserved archaeological contexts. The cemetery and living area at Kiflie Mado were both preserved under thick layers of alluvium and/or colluvium, providing proof of the kinds of contexts and processes likely to preserve archaeological features. In neither instance were artifacts visible on the surface, even though Kiflie Mado was under cultivation. The excavations at Tarla Terrara revealed well-preserved pit features, though these only remained intact because they were cut into the bedrock. Any features or contexts that had originally existed in the overlying soil strata have since been erased by plowing and erosion.

The field seasons were completed with 15 surface collections, though only 12 are considered here for reasons explained above. The surface collections served two purposes. With a dearth of undisturbed archaeological contexts, the surface collections were an alternate means of sampling artifact distributions across the study area. However, combined with topographic data and other variables, they provide a valuable means of assessing how forces and conditions like plowing, trampling, slope, and erosion affect artifact distribution. In turn, this provides a way to better understand the formation



processes active in the area and how they affect archaeological material and artifact patterns, discussed at length in the following chapter.

Combined, all this data provides a good impression of the overall complications of working in the Ethiopian highlands. While the area is certainly rich in artifacts and history as observed during initial reconnaissance prior to fieldwork, the appearance is deceptive. The past century's overexploitation of the environment, possibly stretching back even further, has resulted in extensive deforestation, plowing, and erosion that all appear to have largely disturbed archaeological contexts. Contrary to expectations of scholars like Redman and Watson (1970), in settings like Gännäta Maryam surface assemblages are not indicative of archaeological contexts; they are the last remaining vestiges of their former existence. Archaeological contexts are best preserved where they are sealed beneath layers of soil eroded from elsewhere, and may be difficult to prospect for in future.

## **Chapter 5**

### **Formation Processes at Gännäta Maryam**

#### **5.1. Introduction**

Previous research into landscape dynamics in Ethiopia has primarily been written with agricultural or environmental conservation goals in mind (e.g. Hurni 1978, 1985, 1988; Nyssen et al. 2000, 2004, 2008; Mwendera and Saleem 1997; Mwendera et al. 1997; Gebremichael 2005; Yimer 2006; Muche 2013). In the instances where geoarchaeology has overlapped with archaeological interests, it has rarely been aimed at relatively recent historical archaeology, as this project was. Rather, it has focused on older subjects and areas conventionally explored in Ethiopian archaeology such as Aksumite period sites of Tigray and earlier prehistory (e.g. Butzer 1981; Bard 1997; French et al. 2009). The goal here is to reorient this corpus of work toward the interests and concerns of archaeologists primarily focused on more recent history in more mountainous regions, correlating previous environmental degradation research with the findings of this project to better understand the dynamics of terraced mountain landscapes and their effects on small-scale or ephemeral archaeological sites. It is hoped that this will result in a primer future archaeologists may use to better design their own research when exploring such sites in similar terrain. Read from a cynical perspective, however, this work also cautions against an over-zealous aspiration to explore ephemeral sites in the highland mountains. As we will see, the mountain terraces pose a number of significant challenges to archaeological preservation, and it may be only under the most exceptional or particular of circumstances that successful archaeological reconnaissance can be conducted.

The following chapter will be divided into three parts. The first part will cover basic principles of geomorphology and formation processes relevant to the research area investigated for this thesis. The second part will cover literature on human and natural formation processes and their intersection with one other in the Ethiopian Highlands specifically. The chapter will conclude with an interpretation of the relevance of these processes for understanding the archaeological and general landscape patterns observed during fieldwork, discussed in Chapter 4.

Before delving into the analysis, it is important to clarify that this is not about the metrics of site transformation processes at Gännäta Maryam in the absolute sense; that is, this study in its inception and design was not intended to observe and measure actual environmental degradation events as they occurred in real time, nor was it designed or intended to refine parameters relevant to their study in the same way a geomorphologist might. The reasons for this are twofold. In the very practical sense, such an analysis was not feasible given the circumstances. While such analyses are possible, demonstrated by the many studies cited in the second paragraph above and throughout this section, numerous factors have prevented this. First and foremost, this research project as initially conceived and designed did not have this focus. Quantitative analysis would have required a radically different research program and schedule would have been required, and likely would have exceeded the feasibility of and scope of an archaeology dissertation project. Such research requires the collection of data through time and labor intensive means potentially including, though not limited to weather monitoring devices (e.g. rain gauges, rain intensity studies), long-term (1 year+) monitoring, chemical and physical analyses of soils, timed sediment captures, and other forms of long-term environmental monitoring. Alternatively - or additionally - site selection must have taken into account these factors, considering the receptivity of the community to tolerate such intrusive steps or selecting sites where such facilities and research had already been established.

Secondly, it is uncertain how valuable such an intensive and locally specific study would be to other archaeologists. The geomorphologic and human-induced processes that affect site preservation are complex and intimately intertwined. For example, slope, elevation and aspect all affect rain intensity, which in turn affects soil erosion,

conditioned by slope, soil composition, land use, cover, and season (Hurni 1985; Nyssen 2008). Any such analysis would then be locally very specific, and precise measurements might not be directly translatable from one particular research area in the highlands to another. Similarly, it is unrealistic to expect that archaeologists wishing to work in the highlands would conduct such intensive research on their own in regions of interest prior to archaeological fieldwork, or, conversely, that they would limit themselves to locations where such research has already been conducted. Rather, it is more important that archaeologists understand that such interrelated processes exist in such a state of complexity, and that they are equipped to qualitatively identify and describe the potential roles of such processes in local landscape evolutions as they evaluate the archaeological potential of different areas and regions. When necessary, previous research in Ethiopia conducted for the purpose of understanding landscape dynamics is likely sufficient to general archaeological research in cases where landscape dynamics are not the exclusive object of study, provided the archaeologist has sufficient literacy in the topic to acknowledge where limitations in the data may apply to their own context.

## **5.2. Introduction to geomorphic processes**

Erosion in its various forms is frequently cited as the most active degrading force of the Ethiopian highlands (Hurni 1988: 124; Dejene 1990: 19; Nyssen et al. 2005: 173, 2008: 695; Frankl et al. 2011: 238), and obviously poses a number of serious challenges to archaeologists (Rick, 1976; Wainwright 1992, 1994). Erosion in the highlands takes numerous forms: rills, sheetwash, gully formation, mass wasting, slumping, and fluvial actions; but all share common causes. Rainfall is the primary driving force of erosion in the highlands (Hurni 1988: 124; Nyssen et al. 2005: 273; 2008: 695; Frankl et al. 2011: 238), but its erosive potential is conditioned by factors such as slope angle, local geography and climatology, rain intensity, soil and groundcover conditions, and, most importantly, human landscape use and modification. The following is only a brief summary of basic geomorphological processes relevant to the study area and this research, and does not go into specific formulae and processes expressed quantitatively as

such material is readily available and described in detail in countless introductory texts. This section will outline in approximate order the three stages of rain-induced erosion as they are relevant to the study area: detachment, transport, and deposition. Figure 5.1 summarizes some relevant erosion forms and their controlling factors.

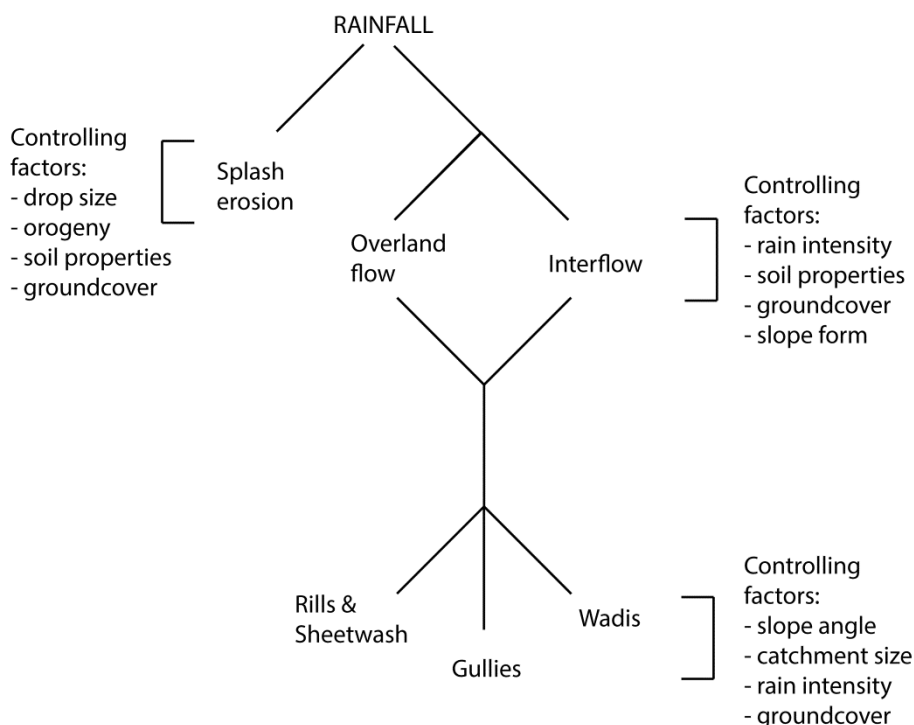


Figure 5.1. Diagram of waterborne erosion and controlling factors relevant to this study

Rainfall acts as an erosive force through a number of complex processes. Over the past century or longer, about 75% of the annual rainfall in the study area and in most of northern Ethiopia, falls in the summer rainy season from June to September. This equals about 735 mm on average during the summer rainy season out of a total 975 mm per year (Climate Research Institute, University of East Anglia 2014). As was noted briefly in Chapter 3, rainfall in the highlands can be particularly erosive due to large drop size and high intensity rainfall (Nyssen et al. 2005), the significance of which will be covered below. This may be attributable largely to the orographic nature of Ethiopian rainfall with the incoming of the ITCZ mid-year and convection movement of the air over the differentially heated terrain as determined by elevation and geology (Krauer 1988 in Nyssen et al. 2005: 173). Measuring drop sizes captured on blotter paper, Nyssen and his

team (2005) concluded that raindrops in the highlands are notably larger than drop sizes measured elsewhere in the world. They correlated this size to the kinetic energy of the rainfall, and applying this value to the (*Revised*) *Universal Soil Loss Equation* (Renard et al. 1997 cited in Nyssen et al. 2005: 185) show that such a high value will necessary result in an appreciably higher soil erosion potential, higher than expected if only rain intensity is factored into similar equations. It also bears noting that while Nyssen et al. were observing rain, hail also falls in the highlands, and according to Hurni (1979, cited in Nyssen et al. 2004: 290), the erosive potential of hail is 2.5 times that of rain.

Their research also shows how aspect and other orographic features affect precipitation in general. In particular, large weather masses like the ITCZ preferentially flow down the lengths of large valleys with axes oriented toward the prevailing air currents, and yield the greatest volume and intensity of rains when such air masses strike topographic impediments. The leeward sides of these impediments, by contrast, receive less rain. Similarly, the aspects of local features relative to the larger valley system also have some possible effect. By contrast, differentiated rock strata (e.g. light and dark colored rocks) and their impacts on convection and changes in elevation appeared to have little correlation to annual precipitation volume. However, topography was shown to correlate with drop size. Higher elevations received slightly larger drops, possibly because the shorter fall exposes them to less turbulence and time for evaporation. Thus, even within a single catchment area, rainfall can vary appreciably at a local scale as determined by local orogeny. On average, Nyssen et al. (2004) found an 80 mm difference between some areas of a single catchment over a monitored time of six years. Unsurprisingly, valleys and valley aspects oriented to catch the ITCZ air currents moving in from the south and east received the highest precipitation.

Average rain intensities ( $\text{mm h}^{-1}$ ) in Nyssen et al.'s study were found to be lower than expected, though not unappreciable. Compared to Greer's (1971 in Nyssen et al. 2005: 183, Table 5) calculations of rain intensity and correlation to erosion (see description of infiltration and rain intensity below), 88% of rainfall was  $<30 \text{ mm h}^{-1}$ , where the corollary threshold for excessive rain is about  $20 \text{ mm h}^{-1}$ . However, the remaining rainfalls of greater intensity, usually persisting for about 30 minutes, greatly exceeded Greer's threshold for excessive rainfall, resulting in a high potential for erosion.

It bears keeping in mind, however, that when applying the lessons derived from Nyssen et al. (2005), their work was conducted in Tigray, in the far north of Ethiopia, while the general trend in rainfall patterns across the country is toward increasing aridity as one moves north from the Awash Valley.

The most immediate way by which hail and large raindrops are linked to erosion is through splash erosion (De Ploey and Savat 1968; Moeyersons and De Ploey 1976; Moeyersons 1983). Raindrops, angled by wind (Pedersen and Hasholt 1995), can induce detachment of soil particles from their larger aggregate, reducing overall soil cohesion, and cause saltation of particles up to a few millimeters in diameter with a net downslope movement. This is particularly active in the first few minutes of rainfall while the soils are still relatively dry. Alternatively, splashing can sort particles into a more densely packed arrangement, resulting in the formation of a soil crust, limiting later infiltration, sometimes significantly, resulting in runoff (Ahnert 1998: 112; Knighton 1998: 28-29). While saltation and detachment by rain itself is not a strong erosive force, it makes soil more amenable to erosion as rainfall continues and begins overland flow (Poesen and Savat 1981; Bissonnais and Singer 1992).

More important to highland erosion are the effects these heavy rains have on soils as they continue to fall, when detachment of soil is combined with soil transport by overland flow and interflow. In Ethiopia, these result in the oft-observed sheet and rill erosion formations, and gully formation. Additionally, slumping and mass wasting must also be considered in certain settings. All these erosive processes function on the principal of plastic flow. In unconsolidated materials like soils and sediments, movement can begin when the force of sheer stress exceeds the resistance of the material being acted upon, its sheer strength (Ahnert 1998: 89). In natural settings like the soils in Ethiopia, the forces involved in determining sheer stress and strength principally include soil consolidation, slope, moisture content, and external forces like gravity, and the drag force of water under rainy conditions. Groundcover, topography, rain duration, intensity, and other factors also play a role.

Key to understanding how water can erode soils, broadly called wash denudation, is the concept of infiltration and flow velocity. The infiltration rate of a soil is the measure of how deeply water can saturate the soil over a given time, expressed as

millimeters per hour (Ahnert 1996: 112). Factors involved in infiltration rate include the grain size of the soil and the related porosity or compaction of the medium. When rain intensity exceeds the infiltration rate of the soil, excess water will concentrate and flow over the surface of the soil ("Horton overland flow" Horton 1945). Once the soil has become saturated, further rain will all flow over the surface. Water will also flow through the soil column, called interflow, whether completely saturated or not. On slopes, the water volume will accumulate in the soil downslope, and when it reaches the saturation point can remerge on the surface as overland flow. Average infiltration rates for loamy sandy soil is about 25-30 mm h<sup>-1</sup>, loam about 12-25 mm h<sup>-1</sup>, and clayey loam about 2-5 mm h<sup>-1</sup> (Ahnert 1998: 113). Vertisols in particular have an infiltration rate of about 10-17 mm h<sup>-1</sup> (Bouwer 1986 in Mwendera et al. 1997: 422). The energy of the water necessary to transport soil is partially a factor of the flow velocity. Various equations exist to calculate flow velocity, accounting for slightly different variables (see Ahnert 1998: 114), though slope gradient and water depth are consistently significant, and the smoothness or resistance of the surface or soil matrix is accounted for in different ways. Generally, steeper slopes or greater water volume correlate to greater velocity, while surface features like irregularities and vegetation can impede flow, reducing velocity.

While detachment and transport are both important then, they may act to greater or lesser extents at different positions across a landscape. Higher on slopes, the potential for detachment may be greater than that for transport because the discharge of water is low and therefore provides little protection against detachment by water tension or submersion. By comparison, lower on slopes, water running the length of the slope is accumulating, thus increasing transport capacity relative to the increased discharge. Detachment, however, decreases or remains constant. Additionally, not all water will continue to flow and accumulate in a cumulatively growing discharge volume downslope. The "effective runoff distance of water" is the length over which it will continue to flow, determined by slope angle, rain depth and duration, and permeability of the slope. During short rains on a long slope, for example, the discharge may flow only so far before the cessation of the rain allows more water to infiltrate the soil without being replenished by rainfall, reducing the volume and thus velocity of the flow and its capacity



to transport soil. Steeper slopes will have greater velocity, and thus a longer effective runoff distance, while longer rains can provide greater rain depth to continue overland flow. As previously noted, rainfall in Ethiopia tends to be frequently short and intense, resulting in high volume and thus high energy overland flows, but with a relatively short effective flow distance.

Slope shape and angle play a key role in the form and outcomes of erosion, and vice versa, with numerous implications for archaeology (discussed below). Generally, greater relief in an area correlates to a proportionate rate of denudation (Ahnert 1998: 17-19). On a hypothetical slope with a low slope angle and high rain intensity or low infiltration capacity, rain will accumulate at the surface and move with a low velocity. This sheet flooding will transport some particles resulting in ephemeral rills and sheet wash, and will be more pronounced on uneven ground or ground with heterogeneous groundcover which serves to concentrate flows. Persistent rilling typically exists on slopes steeper than  $2-3^{\circ}$  (Savat and De Ploey 1982 in Knighton 1998: 30) because of the angle's positive effect on flow velocity and thus erosivity, and decrease in soil shear strength. To put this in perspective, the angle of the vertic slopes at Gännäta Maryam average about  $4^{\circ}$  over their length. At steeper slopes or on less uniform ground, such as rocky, uneven or heavily vegetated ground, water flow will concentrate into preferred flow paths, producing longer, deeper rills, possibly of greater permanency.

On steeper slopes and/or with appropriate topographic variations, repeated rill wash events can form gullies, features characterized by their upslope headcut, steep sides, and narrow width. Gullies often form rapidly and may be seen as evidence for environmental disturbance and instability, such as from deforestation, resulting in greater runoff (Knighton 1998: 30-31). Natural cracks in soils, like those found in Vertisols and vertic soils can also provide ready routes for conducting water, facilitating the formation of rills. On highly permeable surfaces, frequently over less permeable soil or rock strata, pipes can form. Pipes may also form in vertic cracks, when the absorption of water by the upper centimeters of vertic soil causes the cracks to close at the surface. When infiltration is sufficient to initiate interflow, fine particles can become suspended in the moving water transporting the subsurface soils along flow channels. These may emerge as seepage or collapse and also form rills and incipient gullies.

Rain duration, intensity, slope shape and length also significantly influences erosive processes, and, subsequently, slope form and sediment deposition. Given the rate of pedogenesis of a slope relative to the transport of sediments from it, denudation of the slope is said to be either weathering-limited or transport-limited. A slope is said to be weathering-limited when the potential denudation rate of a surface is greater than its sediment accumulation by weathering (either through *in situ* regolith formation, or accumulation of sediment eroded from elsewhere). In the extreme, weathering-limited denudation will expose bedrock near the slope break and deposit colluvium at the base of the slope. By contrast, in transport-limited denudation, the rate of soil accumulation (through *in situ* formation or secondary deposition) exceeds the potential rate of denudation and the slope takes the form of the relevant processes involved in its erosion. Frequently, larger slopes may be characterized by both features, the upper portion of a slope being dominated by weathering-limited denudation where denudation by erosion is often strongest, and transport-limited on the lower slope, where the colluvium from upslope is deposited. Slopes may also undergo denudation by slow mass movement, wash denudation, or a combination of both.

Ahnert (1987) provides useful diagrams for visually identifying slope degradation processes characterized by these processes, which produce unique slope profiles, in addition to describing the physical processes behind such formations. Briefly, however, slow mass movement is the gradual erosion of a surface where incision precipitates gradual erosion of the adjacent slope where runoff is minor, forming a convex slope profile. Where runoff is the primary erosive factor, however, a concave profile forms, unless the effective runoff distance is generally low, causing an accumulation of colluvium near the middle of the slope and a slightly convex bulge downslope to the concavity. Additionally, both forces may be active resulting in a concavity near the slope crest and a convex footslope. It is perhaps unsurprising that in the study area, erosion by wash denudation rather than incision and transport by stream erosion appears to predominate.

Finally, groundcover such as rocks and vegetation is also a mitigating factor. Vegetation can have different, but significant effects on rain-induced erosion. Vegetation cover can interrupt the fall of rain before hitting the ground, thus reducing splash erosion

and detachment. Root masses can also increase infiltration rates while both above- and belowground plant material can reduce the velocity of surface and interflow, respectively. Higher organic matter content can also improve soil cohesion (Blackburn 1975). The effects of larger rocks in fields have also been noted to affect erosion (see discussion in Poesen 2005: 282). Nyssen et al. (2000) observe that erosion on slopes in Ethiopian fields may expose a number of large rocks. Initially, exposure of sufficient small rock fragments may increase surface runoff and thus erosion. However, continued removal of soil will expose additional rocks. When enough rocks of sufficient size are exposed, their presence increases surface roughness, thus decreasing flow velocity, in turn stabilizing soils and improving infiltration. Sufficient weathering of an undisturbed surface may result in the formation of an erosion pavement, a crust of coarse material that can protect finer underlying soil against erosion (Shaw, 1929; Lowdermilk and Sundling 1950; Poesen 2005: 282). Nyssen et al. (2000: 126) believe that rocky groundcover in Ethiopia where rocks are an average of 15 cm or greater may be sufficient to improve infiltration and reduce erodability.

The significance of soil deposition should not be overlooked for the extensive processes of erosion active in the highlands, however. The accumulation of soils in the highlands also plays a significant role in the region's geomorphology and is perhaps just as significant to successful archaeological reconnaissance as detachment and transport erosion processes. Just as shear stress and flow velocity are integral to the entrainment of soils and sediments, so are they key to their deposition. Following upon transport, when the shear strength or velocity of the moving material drops below the threshold for the material in question, it will settle out of the system. Because the size of an object is frequently a factor in its transport rate, sediments will often sort themselves by size as they are deposited along a flow path (Knighton: 1998: 141). Two types of sedimentation are germane here: colluviation/alluviation along slopes, and fluvial processes such as floodplain deposition and meander morphology.

During short, intense rains, particularly on longer, lower slopes, it is possible that flow volume and strength will decline over distance, depositing suspended loads along their course rather than eroding them into ever larger fluvial systems in one event. This may be partially responsible for patterns like the distribution of alluvium around the

bases if inselbergs and other topographic reliefs and the slow creep of soil and artifacts across a field. Alternatively, topographic changes reduce flow velocity, depositing material as in the transport-limited denudation formations discussed above. Frequently in the study area, small rills and gullies descending hillslopes ended in alluvial fans of fine sand and gravel when the flow velocity declined as it spread across the more level fields. In more topographically extreme instances, such as along scarps, larger alluvial fans can form, though in the study area, erosional pediments sculpted by sheet wash are also common and may be confused in the Ethiopian context due to a number of unique factors (see Berakhi and Brancaccio 1993). A key distinction discoverable upon excavation is that the pediments will have a bedrock foundation with only a veneer of aggraded material. In the Highland setting, much of the aggraded material covering the pediments is likely to originate from the retreat of the abutting terrace steps, consisting of erosion from or over the cliff face, and rockfall (see Belay 1998).

The other depositional force is related to fluvial processes, which, though not discussed directly, are inferred above when discussing detachment and erosion. Because gullies and wadis, rather than large perennial water courses, are typical of the terraced highlands, and the literature on fluvial systems is so extensive, broader discussions of fluvial forms and processes will not be dealt with here. The only major relevance of fluvial processes here is in regard to the wadi at the center of the study area and its propensity to meander and deposit alluvium (see Figure 4.6). Water channels like wadis, streams or rivers can take a number of shapes dependant on their flow velocity, conditioned by things like slope, flow volume, bed load, and geological context. When external obstructions are minimal, higher energy streams will often form more linear channels than lower energy streams. At Gännäta Maryam, the wadi channel observed today has a smooth and slightly sinuous channel cutting primarily through soft alluvium along a very low graded surface. Though bedform morphology might provide a good proxy indicator for general flow strength, as different flow intensities produce different structures, the soft sand of the bed at the study area was too heavily trampled by the end of the dry season for such observations. However, the planar sediment strata visible in the west bank profile may be considered. The planar strata, generally of sand to finer sediment, and slightly sinuous morphology all suggest a medium to slightly high flow

velocity (Figure 5.2). Moderately high flow regimes are erosive enough to prevent the formation of topographic features on the bed, like dunes, and instead deposit soil in mass sheets. Meanwhile, sinuous meanders are more often associated with lower energy flows. The combination of the two features is perhaps characteristic of the highland settings, where Billi (2008) argues they result from hyperconcentrated flow regimes. In a hyperconcentrated flow, the discharge is high, with high energy, as one might expect given the highlands relatively short, but intense and regular rainy season rains. The suspended load in the flow, however, is exceedingly high as well, to the point that hyperconcentrated flows may be considered a transitional stage between a fluvial flow and a debris flow (Pierson 2005). This voluminous suspended bedload is perhaps related to the great erosive potential of the poorly protected soils in the highlands, and begs the question how the fluvial morphology of ephemeral channels in the highlands may have been different prior to extensive degradation. Unfortunately, no research relevant to changes in fluvial morphology in similar settings appears to be available at this time.



Figure 5.2. Photograph of the western side of the wadi bisecting the alluvial plain of Tabot Madera. Note the fine alluvial strata and thick, vertic plowzone.

Under a meandering flow regime, the greatest energy and abrasion of the flow is not through the middle, but rather toward one bank or another. This results in the cutting away of one bank under the higher energy and suspended load, the cutbank, and the loss of suspended soil on the opposite low energy side, the point bar. As a meander continues to develop and move, new soil continues to be carved away progressively down the flow path, while later accretion occurs progressively over point bars.

### **5.3. Ethiopian highland formation processes**

Environmental degradation in the highlands has been studied at length by numerous researchers, often with improved agricultural sustainability as the end goal. While human impacts on the environment have clearly contributed to land degradation

(outlined below), it is also important to first establish a baseline level of human and natural landscape dynamics before the effects of individual practices is comprehensible in their contexts. The following is a summary of the state of the landscape in the Ethiopian highlands as it has been generally observed, to be followed in the next section by how particular practices more specifically impact landscape evolution.

Hans Hurni, manager of the Switzerland-sponsored Soil Conservation Research Project in Ethiopia has compiled and produced some of the most foundational research on the state of the Ethiopian highland landscape and its modern degradation under human use (e.g. 1983; 1985; 1986, 1988; see also Ethiopian Highland Reclamation Study Final Report v.1 1986). Perhaps his most cited and germane contribution was the adaptation of the *Universal Soil Loss Equation* ("USLE," Wischmeier and Smith 1978), developed by research in North America, to an Ethiopian setting by adjusting the values of factors like rainfall erosivity and soil erodability to local conditions (Hurni 1985). From there, he produced a table estimating annual soil loss by land-use type, reproduced in Table 5.1 along with the USLE equation.

Table 5.1. Hans Hurni's report of *Universal Soil Loss Equation* factors calibrated for use in Ethiopia (Hurni 1985a, reproduced by Nyssen et al. 2004).

The Universal Soil Loss Equation (USLE) adapted for Ethiopia (Hurni, 1985) ( $R$  in  $J\ cm\ m^{-2}\ h^{-1}\ year^{-1}$ ,  $K$  also in SI units, following Wischmeier and Smith's (1978) conversion coefficient)

---

THE UNIVERSAL SOIL LOSS EQUATION (USLE) ADAPTED FOR ETHIOPIA

---

SOURCE: WISCHMEIER AND SMITH, 1978

ADAPTIONS: R CORRELATION: HURNI, 1985

K VALUES: FROM BONO AND SEILER, 1983, 1984; AND WEIGEL, 1985

S EXTRAPOLATION: HURNI, 1982

EQUATION:  $A = R * K * L * S * C * P$  (TONS PER HA PER YR)

1. R: RAINFALL EROSIVITY

ANNUAL RAINFALL (MM)	100	200	400	800	1200	1600	2000	2400
ANNUAL FACTOR R	48	104	217	441	666	890	1115	1340

2. K: SOIL ERODIBILITY

SOIL COLOUR	BLACK	BROWN	RED	YELLOW
FACTOR K	0.15	0.20	0.25	0.30

3. L: SLOPE LENGTH

LENGTH (M)	5	10	20	40	80	160	240	320
FACTOR L	0.5	0.7	1.0	1.4	1.9	2.7	3.2	3.8

4. S: SLOPE GRADIENT

SLOPE (%)	5	10	15	20	30	40	50	60
FACTOR S	0.4	1.0	1.6	2.2	3.0	3.8	4.3	4.8

5. C: LAND COVER

DENSE FOREST:	0.001	DENSE GRASS:	0.01
OTHER FOREST:	SEE GRASS	DEGRADED GRASS:	0.05
BADLANDS HARD:	0.05	FALLOW HARD:	0.05
BADLANDS SOFT:	0.40	FALLOW PLOUGHED:	0.60
SORGHUM, MAIZE:	0.10	ETHIOPIAN TEF:	0.25
CEREALS, PULSES:	0.15	CONTINUOUS FALLOW:	1.00

6. P: MANAGEMENT FACTOR

PLOUGHING UP AND DOWN:	1.00	PLOUGHING ON CONTOUR:	0.90
STRIP CROPPING:	0.80	INTERCROPPING:	0.80
APPLYING MULCH:	0.60	DENSE INTERCROPPING:	0.70
STONE COVER 80%:	0.50		
STONE COVER 40%:	0.80		

---

Since Hurni's writing, the USLE has been updated to the *Revised Universal Soil Loss Equation* (Renard et al. 1997), which is fundamentally the same equation, though with different sub-equations for determining the values of some factors. Nyssen et al. (2004) recommend this iteration of USLE, though note the accuracy of both are limited to small scale areas, rather than whole regions. At regional scales, the range of variation in measurements of topographic factors and land cover results in a large margin of error (Nyssen et al. 2004: 294-295). More recently, Muche et al. (2013) compared in a study of actual erosion rates the efficacy of the USLE to a second variation, the *Modified Universal Soil Loss Equation* (MUSLE, Williams 1975) to see which predicted soil losses in Ethiopia with greater accuracy. Again, both equations are similar, though have significant differences. Whereas USLE predicts annual soil loss, MUSLE predicts



sediment yield from an individual storm event. MUSLE also replaces the factor value for rainfall (R) with factors for storm runoff volume (Q) and peak runoff rate ( $q_p$ ). They found that using runoff as a variable rather than rainfall resulted in a roughly 25% more accurate prediction of soil loss, though even the MUSLE estimate fell short of actual measured soil loss by about 30%. The obvious problem with the MUSLE equation for model building by archaeologists, however, is that runoff and runoff rate are not as easily obtained for any research area in Ethiopia as rainfall, and will be significantly different in rainfall events during different seasons of the year. Additionally, the application of any of these formulae by archaeologists to their region may be difficult, as all require observations of conditions that may be beyond the reach of most field archaeologists. For example, for the RUSLE formula, the measure of total storm energy over time, ideally a full year or more, is necessary to calculate the rainfall erosivity factor (R), while percentages of different grain sizes composing a soil are necessary for calculating the soil erodibility factor (K). In ideal circumstances, such factors may be derived from the research of others, though this is rarely likely to be the case. At Gännäta Maryam, for example, no such locally specific data is available, and the USLE with Hurni's initial estimates (1985) may have to serve as a general stand-in for most purposes unless the necessary observations are expressly incorporated into a research project design.

The estimates are exclusively soil lost to erosion, however, and do not consider soil accumulation or redeposition within a research area due to factors like pedogenesis, alluviation, or colluviation. Equivalence of tonnage to depth of soil loss depends on the soil's density, though  $12 \text{ t ha}^{-1}$  is equated to about 1 mm of soil in some US studies (Montgomery 2007: 13268), though this equivalence is not necessarily of great value when the dominant form of erosion is something like gully expansion, rather than more uniformly distributed sheet erosion. Interestingly, Hurni (1988: 127) reports that soil formation is slightly higher on cultivated soil than uncultivated soil because of the mechanical destruction provided by plowing, though this minor difference ( $\leq 4 \text{ t ha}^{-1}$ ) is significantly offset by the extreme rates of erosion, many times greater than the rate of pedogenesis. Even on uncultivated land, soil loss frequently exceeds soil generation by a factor of 0.8-2.3, equaling between about 2-4 tons  $\text{ha}^{-1} \text{ year}^{-1}$ . This may generally be bad news for archaeologists working in highland settings. Again, this factor does not

consider soil redeposition and does not necessarily imply uniform horizontal stripping of soil, but it suggests in this estimate that soil strata are being removed at a rate of 1mm every 4-6 years. Only in settings where alluviation/colluviation exceed these rates might archaeological deposits remain at least partially protected from complete erasure. Based on the discussion of deposition above, promising areas to examine in the future may in fact be areas where colluviation or alluviation have been extreme, burying archaeological deposits by material eroded from elsewhere. In such instances, surface surveying is unlikely to be helpful.

Also important is Henricksen et al.'s (1983) soil survey and the soil maps produced by Barber (1984) (reproduced and tabulated in Hurni, 1988). Based on this data, the severity of soil erosion as estimated in the mid-1980s was considered "extreme" for the then-designated Wello region, today encompassing Gännäta Maryam and much of the middle highlands abutting the Afar depression (see reproduction, Figure 5.3). The designation of "extreme" is defined as "over 80% of the soils are about 20 cm deep only, and the rest about 100 cm" (Figure 5.3; Hurni 1988: 125, Figure 2). Erosion in the majority of the rest of the northern highlands are considered "very serious", meaning about 60-80% of their soils are about 20 cm deep or less. Twenty centimeters in these estimates is considered about the limit for successful agricultural production due to the limited rooting depth and moisture retention, and less than 10 cm insufficient for grassland regeneration or afforestation efforts. Table 5.2 reproduces Hurni's tabulation of soil depths for relevant regions of the northern Ethiopian highlands. Hurni estimates that in pristine condition, natural soil depths in much of Ethiopia would likely be greater than 50 cm deep, and as much as 100 cm. All these figures are averages, however, and it must be remembered that topography and elevation play a role in determining soil depth, such that areas like the alluvial plain at Gännäta Maryam have accumulated soils nearly two meters deep in some areas, while soils on the hills and upper terraces are starkly more shallow, as low as 30 cm in some locations like Tarla Terrara Hill, according to excavations.

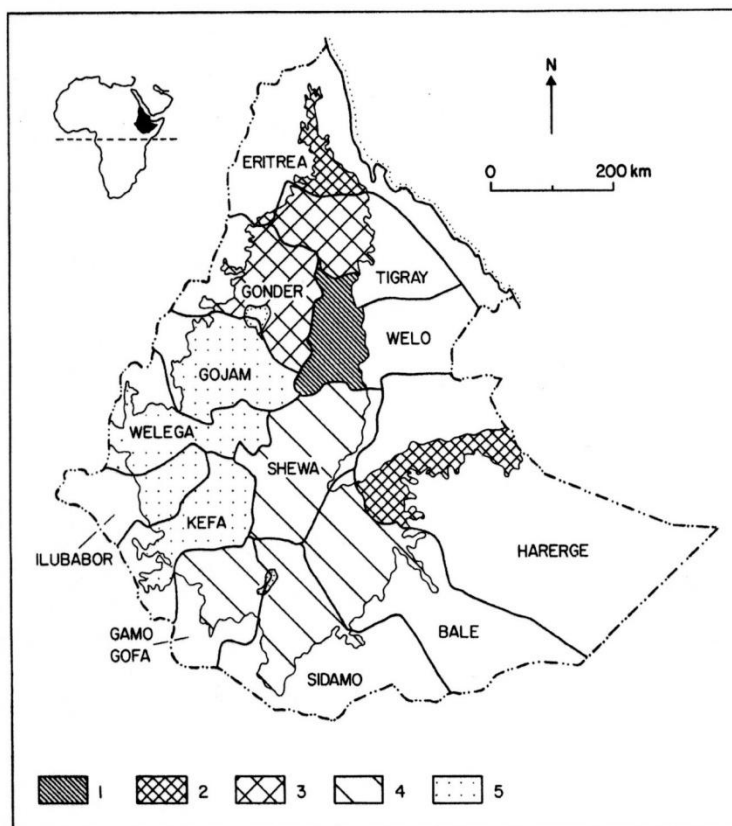


FIGURE 2. Severity of soil erosion in the Ethiopian highlands.

Key

- 1: extreme (over 80% of the soils are about 20 cm deep only, and the rest about 100 cm);  
 2: very serious (60-80%);  
 3: high (40-60%);  
 4: medium (20-40%);  
 5: slight (less than 20%).

Source: from Table 1, generalized for the highland area of each region.

Figure 5.3. Severity of soil erosion in the Ethiopian highlands reproduced from Hurni (1988: 125: Figure 2).

Table 5.2. Average soil depths in different regions of Ethiopia reproduced from Hurni (1988: 125: Table 1, based on Barber [1984] and Henricksen et al. [1983]).

*Areas with different soil depths in the highland areas of Ethiopia, by administrative region in percent of the respective highland parts of each region; calculated from maps of Barber (1984), based on Henricksen et al. (1983)*

Region	Total area in km <sup>2</sup> (= 100%)	Area above 1,500 m asl in % of region	Area of soil depth class in % of highland area above 1,500 m asl (highland = 100%)				Lake area (% of high.)
			130 cm	75 cm	35 cm	10 cm	
Eritrea	123,800	12.5	11.1	12.3	20.2	56.4	
Tigray	65,900	53.9	11.7	30.1	46.0	12.2	
Welo	80,800	40.4	6.2	4.2	17.6	72.0	
Gonder	73,800	67.8	12.5	38.5	22.1	22.3	4.6
Gojam	61,900	84.5	63.7	20.0	13.5	1.3	1.5
Shewa	80,900	86.6	49.3	18.2	8.7	22.2	1.6
Wellega	69,900	58.8	76.7	3.4	17.8	0.7	1.4
Illubabor	48,900	39.3	67.0	14.4	12.2	6.4	
Kefa	52,400	80.8	69.9	22.7	1.0	6.4	
Gamo Gofa	40,200	76.0	39.5	36.6	9.9	11.1	2.9
Sidamo	118,100	38.5	60.5	15.1	17.9	6.2	0.3
Arsi	24,100	70.4	68.3	18.3	1.8	11.6	
Bale	123,900	28.5	37.5	28.4	18.9	15.2	
Harerge	257,400	13.6	20.6	18.4	24.2	36.8	
Total	1,222,000	42.6	43.7	20.7	16.4	18.1	0.5

None of this is meant to suggest, however, that Ethiopia generally lacks buried soil horizons. The problem is identifying areas where soil aggradation exceeds soil removal resulting in well-preserved soil strata. In another study of a single catchment, Hurni (1985) found that only about 30% of soil displaced by erosion actually left the catchment, the majority of soil being captured by changes in topographic relief elsewhere. In a similar study in Tigray, Nyssen et al. (1997) quantified soil loss by erosion through various means such as sheet, rill and gully erosion, instigated by plowing, trampling, the natural topography, and other factors (see below). However, they also factored into their analysis soil recapture through environmental remediation efforts like stone bunds and gully check dams. In their final analysis, they conclude that 59% of eroded soil is recaptured in the catchment (Nyssen et al. 1997, also cited in Nyssen et al. 2015: 377). Fifty-five percent of sheet and rill erosion is caught far downslope on the stepped landscape in hillside exclosures while stone bunds in fields managed to capture 61% of soil eroded across those fields. Tamene et al. (2006) come to a similar overall conclusion to Nyssen and his team (1997) in their multi-catchment study: while initial estimates of soil loss in some catchments were greater than in others, remediation efforts in fact have significant effects on soil recapture within the catchment, such that net loss is significantly reduced. While floodplains like that at the core of the Gännäta Maryam study area are also likely capturing some sediment from the upper fields, as discussed previously and below, Nyssen et al. (2015: 377) note that this locus for sedimentation has not yet been studied systematically.

In perhaps the most comprehensive study of erosion and deposition in a single catchment, Nyssen et al. (2008) set out to study the "evolution of geomorphic process rates at different timescales, [and] to differentiate between natural and anthropogenic causes." The end-goal was an attempt to calculate a sediment budget, a multi-factored evaluation of soil displacement, removal and/or redeposition, across what they believed to be a representative catchment in Tigray (Nyssen et al. 2008: 696). The study area is perhaps not significantly unlike Gännäta Maryam, though larger. The only immediate differences are the lower annual rainfall received in the study area, being north of the Wollo region (~ 100mm less), and the presence of some sedimentary rock strata compared to the predominantly volcanic strata of the Mount Abuna Yosef region.

Regional patterns of land use are similar, with the majority of the landscape used for permanent agriculture and steep lands ( $>15^\circ$ ) used for grazing, though much of this latter land has been closed off to animals. Factors studied in the sediment budget included soil loss due to sheet, rill gully, and tillage erosion, soil creep, rockfall, and the mitigating or exacerbating effects of soil and water conservation measures like stone bunds, exclosures, and road construction. To these directly observed metrics, they also considered previous research on these issues, much of it conducted by teams with Nyssen and colleagues previously. Among all the observed factors, landslides and rockfall were believed to be largely natural processes. Soil creep, or reactivation of soil creep, was partially a natural processes induced by local conditions, though potentially instigated or exacerbated by activities like slope undercutting for roads, and establishment of exclosures. Erosion induced by gullies, sheet and rill erosion, tramping and tilling were primarily all anthropogenic in cause, though at least partially conditioned by weather, pedology, and topography. Table 5.3 is a reproduction of Nyssen et al.'s net findings regarding the rate of geomorphic processes in their study area, while Figure 5.4 is a visualization of their sediment budget. More specific results of factors inducing erosion or sedimentation are discussed below. Research similar to Nyssen et al.'s (2008) work has been conducted, though with a strongly statistical and technical orientation, testing the statistical significance and relatedness of different controlling factors and the variability within those factors (e.g. Tamene 2006; Haregeweyn, Poesen, Nyssen et al. 2008), much of which is summarized and adapted by Nyssen et al. (2008).

Table 5.3. Rate of geomorphic processes in study area of May Zegzeg study area, expressed as sediment yield (reproduced from Nyssen et al. 2008)

Process	Scale of observation		Land unit		Specific rate (t ha <sup>-1</sup> y <sup>-1</sup> )	Total rate (t y <sup>-1</sup> )
	(space)	(time)	name	(ha)		
Sheet & rill erosion <sup>a</sup>	plot	3 y	cropland	133.0	9.9	1317
	slope	7 y	rangeland	42.3	17.4	736
	slope	7 y	exclosures	21.5	3.5	75
			Subtotal <sup>b</sup>	199.1	10.7	2128
Gully erosion <sup>c</sup>	catchment	3 y	catchment	199.1	4.1	816
			Subtotal water erosion	199.1	14.8	2944
Estimated deposition rates of sediment transported by water						
Exclosures <sup>d</sup>	study area	3–15 y	exclosures	21.5	55.0	1183
Cropland (behind SWC structures) <sup>e</sup>	estimated mean (61% of eroded soil)			66.5	6.0	402
Gullies <sup>f</sup>	debris fans (30% of eroded soil)			199.1	1.2	239
Sediment deposition in catchment					9.2	1823
Other lateral transfers within the catchment						
Tillage erosion <sup>g</sup>	within the plot	experim.	all cropland	133	7.8	1037
Soil creep <sup>h</sup>	slope	2 y	steep slopes	3.3	1.5	5
Landslides	study area	– no evidence and not observed in the catchment during 4 y				
Rockfall <sup>i</sup>	sandstone cliff	4 y	cliffs	2.3	34.7	80
Trampling <sup>k</sup>	steep slopes	2 y	– rangeland	42.3	1.3	55
			– exclosures	21.4	0.1	3
Sediment yield <sup>l</sup>			Catchment	199.1	5.6	1121

<sup>a</sup> Data from Nyssen et al. (2007c), based on mean of monitored rates.

<sup>b</sup> Includes also stone fenced homesteads (zero runoff) and gullies (accounted with gully erosion).

<sup>c</sup> Data from Nyssen et al. (2006c), based on measurement of gully volumes and estimation of their age.

<sup>d</sup> Based on measurements of sediment accumulation rates in exclosures by Descheemaeker et al. (2006).

<sup>e</sup> According to Nyssen (2001), taking into account that stone bunds are established on half of the cropped area (Naudts, 2001, unpublished M. Sc. thesis).

<sup>f</sup> Gully volumes were measured taking into account the effect of checkdams – here only deposits in debris fans are taken into account.

<sup>g</sup> Based on Nyssen et al. (2000b), estimation of tillage transport coefficient for the study area  $K = 68$ , two tillage operations (the third, during sowing, being very superficial), for each slope class<sup>h</sup>, the mean slope gradient was taken; area-weighted averages; mean plot length between two stone bunds: 30 m.

<sup>h</sup> Flat to sloping, 0–0.15 m m<sup>-1</sup>; moderately steep, 0.15–0.30 m m<sup>-1</sup>; steep to extremely steep, >0.30 m m<sup>-1</sup> (Van Zuidam, 1986).

<sup>i</sup> Based on Nyssen et al. (2002a); on basaltic mass movement deposits on steep slopes; mean length: 300 m.

<sup>j</sup> Data from Nyssen et al. (2006b), mean yearly horizontal displacement 37 m.

<sup>k</sup> Essentially by livestock trampling, but also by concentrated runoff or walking; interpolation based on estimated rock fragment transport coefficient  $K$ , see Nyssen et al. (2006b); area-weighted means, taking into account lithology and slope gradient class<sup>h</sup>; mean slope length estimated at 100 m.

<sup>l</sup> Total water erosion – sediment deposition.

#### Northern Ethiopian Highland soil erosion rate dynamics and controlling factors

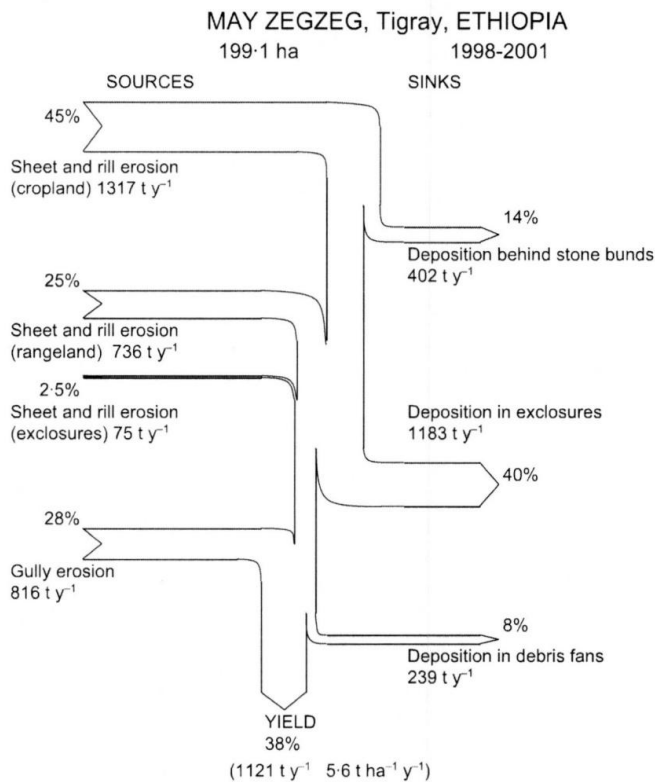


Figure 5.4. Sediment budget of the May Zegzeg study area (reproduced from Nyssen et al. 2008).

While these rates of sediment redeposition within the catchment are encouraging for agriculture, their benefits to archaeology are conditional. Erosion of any sort, clearly, is bad for archaeology. Sedimentation may be good where the sediments can help protect or cover archaeological remains, though this may also prevent their detection. Furthermore, sediment recapture does not mean sediment loss in the same area isn't taking place. An area could, theoretically be undergoing both sediment loss and gain, with an overall net gain. This would not preclude, however, destruction of archaeological features by rills or gullies, sediment wash, creep, and other effects even where soil is being gained.

#### 5.4. Human impacts on landscape degradation in Ethiopia

Human intervention on the landscape, through means like deforestation, agricultural intensification, and livestock raising, has been and continues to be perhaps

the single largest contributor to the intensity of erosion in the Ethiopian highlands (e.g. Dejene 1990: 3; Turkelboom et al. 2008). Berakhi et al.'s (1998) study of geomorphology and soil stratigraphy in Tigray shows a marked increase in alluviation coinciding stratigraphically with the appearance of artifacts and, chronologically, the growth of agriculture in the highlands. While natural climate change likely played some role, it was not the sole force. Ciampalini et al. (2012) examined plough marks and surface wear on large field stones around Aksum. He also concluded that human intervention in the landscape, possibly exacerbated by natural climate change, induced increasing soil runoff, but also reduced or helped protect soil from runoff in other areas where soil management practices were adequate for the setting. Butzer (1981), in his influential work on the geomorphology around Aksum, also posited that intensifying land use around Aksum led to the deterioration of the landscape and the city's gradual abandonment, though the accuracy of Butzer's interpretations have since been challenged by French et al. (2009).

Broader geomorphologic and environmental studies have also made tentative links between human modifications of the landscape and landscape degradation over the past few millennia (Machado and Perez-Gonzalez 1998; Bard 1997; Bard et al. 2000). In general, many researchers conclude that as a general trend, growing populations and intensifying land use have and continue to correlate positively with land degradation in Ethiopia (Hurni 1988; Dejene 1990: 1, 30; Grepperud 1996; Berakhi et al. 1998; Darbyshire et al. 2003; Nyssen, Simegn, and Taha 2009: 231). Other researchers have also commented on the historical conservatism of Ethiopian land use practices (Crummey 1983; Grepperud 1996: 31; Nyssen et al. 2000: 117; Gebregziahber et al. 2006: 131). This suggests that until the recent reforms of the 20th-century, and possibly barring major social disruptions like the historic incursion of pastoral Oromo, warfare or famine, human-induced environmental degradation has continued along a similar pattern throughout the recent historical past, if not longer.

How do all these processes interlink and correlate to increased rates of erosion? Briefly, Ethiopia's draught plow system requires the labor of animals, animals which require extensive resources throughout the year and damage the environment they live in. The plowing system itself puts intensive pressure on the landscape and accelerates the



rate of erosion by a number of means. Finally as was briefly discussed previously, increasing population and land pressures over the past century have exacerbated all the immediate problems caused by this system. The following summarizes the many means by which traditional Ethiopian agriculture positively affects highland land degradation and provides some quantified data on the extent of this degradation in terms of soil loss, groundcover, and other relevant metrics (Table 5.4).

Table 5.4. Summary of relevant anthropogenic erosion processes and mitigating factors

	Processes/feature	Effect	Controlling factors
Erosion	Plowing	Destabilizes and moves soil	Slope; groundcover; rainfall
	Grazing	Reduces groundcover	Grazing intensity; soil properties
	Trampling	Reduces infiltration potential / increases overland flow potential; facilitates aeolian erosion; moves soil	Soil type; slope
	Roads, footpaths	Reduces infiltration potential / increases overland flow; concentrates flow, expands catchment area	Surface type; slope; location relative to topography and catchment
Mitigation	Groundcover (presence or restoration of...)	Stabilizes soil; reduces erosion potential in numerous ways	
	Bunds, lynchets and other artificial barriers	Recapture lost soil - gradually reduces slope; reduces downcutting in gullies	

Traditional Ethiopian subsistence practices combine plow agriculture with the animal husbandry necessary to provide the draught labor for the plowing itself (Gebregziabher et al. 2006: 130). Processes and results of both contribute to an accelerated rate of erosion in the highlands. The traditional Ethiopian ard plow, or *maresha*, typically consists of an axel attached to a yoke for two cattle at one end, and the scratch plow at the other. The plow tip is an iron spike attached to a shaft pulled by the oxen and controlled by the farmer, who stands over the plow to provide vertical pressure while the oxen provide horizontal drag. Importantly, the plow does not turn the soil over like a moldboard plow, but merely breaks up clumps and push them to either side of the furrow (Gebregziabher et al. 2006: 133). Thus, additional passes with the plow, determined by soil type and intended crop, are needed to sufficiently break up the soil

mass, typically between one to four (Nyssen et al. 2000: 199) or three to five passes (Gebregziabher et al. 2006: 133). Observed from our excavations and shovel tests, the depth of the plowzone was regularly about 15 cm, though Gebreslasie et al. (2004 in Gebregziabher et al. 2006: 113) cite the final pass can achieve a depth of 20 cm. More conservative estimates, however, seem to support our observations of an average depth of 10-15 cm or less (Fleur 1987, Hunting 1976, and Goe 1999 in Nyssen et al. 2000: 122). Nyssen et al. (2000: 119) report that, in Tigray at least, since the widespread introduction of stone bunds under the Derg's land management initiatives, plowing is done parallel to the contours of the ground, beginning at the lower elevation of the field and working up. Casual observation and review of photographs from our study area suggest this is the common practice currently at Gännäta Maryam as well. However, Dejene (1990: 105) notes that among populations resettled in southwest Ethiopia from the north, at least, contour plowing was not necessarily practiced regularly in the early 1980s, and thus possibly was not so uniformly practiced among earlier generations.

Nyssen et al. (2000) attempted to quantify soil erosion and redeposition behind bunds caused by plowing at test fields in Tambien district, Tigray. Their observations are important not only to understanding the relative extremities of plowing-induced soil movement, but also potential for modeling artifact movement in the region. Nyssen and his team's initial observations were that farmers plow on the contour of their fields and attempt to keep the plow perpendicular to the slope. The result is that the plow's "ears," wedges that help to create the furrow, tend to preferentially push soil to the downslope side of the plow. How much and how far soil moved downslope was an effect of slope angle, steeper slopes clearly allowing for longer displacement. Tracers, small marked stones averaging between 3-5 cm in diameter, or about the size of many ceramics recovered in surface collections, were placed along the field perpendicular to the slope and plowing direction. The fields were then plowed two and four times. On average, the net downslope displacement of the tracers was about 4.7 cm on the flattest slope ( $<2^\circ$ ) to about 34.4 cm on slopes up to  $25^\circ$ , though variability was quite large (Nyssen et al. 2000: 123). Average displacement measured parallel to the direction of the plowing was not reported as quantified data, but they note that parallel displacement decreases with increasing slope. Additionally, it was observed that on fields considered to have

numerous large rock fragments, downward displacement was less than on clear fields, the rocks providing a buffer against erosion.

Long-term observation of soil colluviation behind stone bunds also showed an expected pattern. Four to five plots behind stone bunds up three different slopes were observed. Generally, soil on the field below a bund washes down and collects over the original soil surface abutting the next lower bund. The upper surface is thus truncated while the whole surface becomes more level. All bunds being about the same height, however, there is less volume behind bunds on steeper slopes so soil catchment can actually be lower than on more level slopes. Unsurprisingly, net soil loss by tilling is also dependent on slope, increasing as a slope becomes steeper. Calculations of actual soil loss averaged from 0.01 to 0.08 m<sup>2</sup> m<sup>-1</sup> on slopes ranging from 4° to 25° tilled two to four times per year. In concluding, Nyssen et al. surmise that about half of all soil deposited behind stone bunds annually is a result of tillage alone. Gebremichael, Nyssen et al. (2005) conducted similar experiments of soil translocation due to tilling in Tigray, with the additional aim of assessing the effectiveness of stone bunds for erosion control, and achieved similar results.

A second major factor in human-induced erosion is grazing and trampling by cattle (Dejene 1990: 23-26). Reviewing the work of his predecessors, particularly Hurni (1986), Dejene argues that cultivation of soil alone (tillage plus rain erosion) cannot account for the extremity of erosion observed in the highlands. He points out that grazing patterns of livestock likely also play a role. As was discussed earlier, livestock populations in the study area are perhaps low today, though that was not always the case and may not be the case in areas targeted for research in the future. Dejene (1990: 25-26) notes two ways by which livestock augment the rate of erosion in the highlands: grazing and trampling. Trampling kicks up dust, leading to aeolian erosion while also compacting the soil surface. This compacted, or crusted, soil is then less permeable to water, increasing the likelihood and severity of overland flow, thus leading to an increased potential for sheet and rill erosion, or worse. Grazing additionally removes groundcover when done on hillsides and wooded areas, and continues to disturb cultivated soils after harvests by uprooting root masses and trampling.

While Dejene does not quantify the extent of animal-induced erosion, Mwendera et al. have studied the problem in Ethiopia using a set of test fields near Addis Ababa with slopes of 2-7° on which animals were granted differential access ranging from no access to unrestricted access (Mwendera et al. 1997). All representative livestock for the region were grazed on the plots, though their mass was converted to a standardized "Tropical Livestock Unit" ("TLU," Le Houerou 1989) and grazing pressure to TLU per hectare and per time. The most heavily grazed units were grazed with a 1.2 TLU ha<sup>-1</sup>, approximating the average grazing pressure in the region of their study, though perhaps higher than Gännäta Maryam currently. The low vertic slopes in their research area roughly corresponds to the vertic slopes at Gännäta Maryam, both about 2-4°. On these slopes, events such as surface runoff and soil loss were measured after 5 different 13mm rainfall events throughout the rainy season, and biomass was measured each month for a year. In their study they concluded that steeper slopes (>5°) receive the most grazing pressure because they are not cultivated in the study area, and thus open to grazing year-round. Biomass is also naturally lower on increasingly steeper slopes throughout the year, and so is more readily prone to denudation. On all slopes, moderate grazing pressure increased runoff by an average of 35% compared to the ungrazed land, while heavy grazing increased runoff by about 50%. Slope alone did not seem to affect soil loss beyond 3-4°, but was strongly affected by grazing pressure: ungrazed pastures lost between 0.041-0.144 t ha<sup>-1</sup> of soil, while soil loss on medium to heavily grazed soil was regularly about 20% or more, as much as 70%, reaching 0.882 t ha<sup>-1</sup> on the steepest and most heavily grazed slopes. By comparison, these rates of erosion even at moderate grazing, less than is typical for Mwendera's study area, risked a soil loss rate on the moderate to steeper slopes greater than the approximate rate of pedogenesis calculated by Hurni (1985) and Hellden (1987, cited in Mwendera et al. 1997) thus resulting in severe erosion and land degradation. Mwendera et al. (1997) admit that some limiting factors of their research, such as the small catchment size, likely cause slightly inflated soil loss measurements, though they believe the relative trends are seen in their research are accurate. Though their emphasis is primarily on land management and agricultural sustainability, for archaeologists it is clear that any soil loss can expose and endanger sites. Soil erosion rates sufficient to endanger agricultural sustainability are almost surely

sufficient to expose if not destroy ephemeral archaeological sites regardless of the rate of pedogenesis from the underlying regolith.

A second study conducted by Mwendera and Saleem (1997) was similar to the above and largely confirmed their initial findings, though groundcover was also considered in greater depth, and the impact of trampling on soil infiltration rates was evaluated. Regarding groundcover, they found that while some grazing pressure, reducing vegetation cover, did not significantly affect runoff or soil loss, after a certain limit of groundcover loss, runoff and soil loss accelerate exponentially with increasing slope and decreasing groundcover. Seventy-five to 85% groundcover was found to be the minimum necessary groundcover for soil maintenance on slopes between 0-8°. Regarding trampling, they concluded that grazing, land use, and soil type all play a role.

Two fields were studied: the first site was characterized by a fine silty, vertic soil with a slope between 4-8°, while the second had a coarser cambic soil with a slope of 0-4°. Both fields in their fallow state were subjected to varying intensities of grazing, and then were plowed and grazed. On the coarser cambic soils, trampling reduced infiltration below its natural state by about 5-6 mm ha<sup>-1</sup>, regardless of the intensity of the grazing. Only trampling by very heavy grazing on soil that had recently been plowed slightly reduced the infiltration rate below the range measured on vegetated fields. By contrast, on the first field with the fine-textured soil, grazing pressure did significantly affect infiltration rates. The undisturbed soil had an infiltration rate of about 17.6 mm h<sup>-1</sup>. With only light grazing (0.6 aTLU per hectare for one hour, once a week), infiltration was reduced to 11.6 mm/h. With 4.2 animals per hectare for seven hours per day, every day, infiltration rate was reduced to 5.3 mm/h. Plowing the field and allowing the same high intensity grazing further reduced infiltration to 2.4 mm/h.

Thus, trampling does play a significant role in reducing infiltration, and thus increasing surface runoff and soil loss, particularly when groundcover is reduced below a certain threshold, and most especially when the soil has been plowed and devoid of groundcover after harvesting. Soil composition also appears to play a role. Finer soils can be compacted more densely, and thus can reduce infiltration more readily than coarser soils, an observation Mwendera et al. (1997: 34 citing Busby and Gifford 1981) note had been observed elsewhere in the world as well. It must be remembered too that

trampling comes not only from grazing, but from practices such as driving animals to grazing lands and markets, penning them around homes, and the use of oxen in threshing, which can leave smooth, compacted surfaces that we could see during surveying and are possibly the bright marks seen in some satellite imagery of the area. Human trampling around homesteads, house clusters and working areas could also affect infiltration and overland flow. Unfortunately, while aeolian erosion is also visible when one watches residents drive sheep in high winds, the impact has not yet been studied (see Nyssen et al. 2015: 376-377), though it is likely insignificant by comparison to other causes of erosion.

Finally, other forms of compaction and changes to infiltration ought to also be considered. Though they are perhaps less significant than others in the Gännäta Maryam study area, different settings elsewhere in the highlands may require the recognition of the roles played by anthropogenic features like roads and footpaths. The use of footpaths inevitably leads to compaction in much the same way as animals, though many footpaths in the study area were used by humans and animals alike. Some footpaths even had recently excavated bank and ditch features along their margin, suggesting runoff along the paths was observed and possibly considered a problem. While the effects footpaths have on erosion, runoff, or infiltration have not been assessed in Ethiopia, they have been studied elsewhere. Dunne and Deitrich (1982: 48-49) observing mountainous areas of Kenya argue that while rural roads (unsealed earthen roads) and footpaths made up only two percent of the ground coverage, they may be implicated in as much as 25-50% of the local sediment budget. Harden (1992) has also studied the effects of footpaths on runoff, in Tennessee and Ecuador. While his research areas differ from the Ethiopian highlands in numerous regards, he concluded that the cleared and compacted surfaces of footpaths have lower infiltration rates than surrounding soils and help to concentrate overland flow contributing to the formation of erosion features and soil loss. While most paths in the study area are probably too small to contribute significantly to local land degradation in the face of more serious conditions like those outlined above, some areas are clearly nexuses for multiple paths exposing some areas to much greater pedoturbation. The saddle between Tarla Terrara and the path leading up to Agay Midir, for example, is crossed by a number of intersecting paths, linking people crossing from both areas, in addition to going to and from Gännäta Maryam Church, Village, and market, with the

homesteads around Tabot Madera and beyond (Figures 5.5.-5.6.). Here, the ground surface has clearly been compacted heavily in places, likely also dislocating artifacts, kicking them away from the heavily trafficked central intersections, also discussed in Chapter 4. In Figure 5.6 one can even see an incipient gully head forming at the edge of the saddle, possibly influenced by the surface compaction.



Figure 5.5. View of the saddle between Tarla Terrara (background), and Tabot Madera (left). The paths lead to Tabot Madera, the Village and Church of Gännäta Maryam (right) and Agay Midir (behind the photographer). Note the formation of an erosion pavement and the exposed beige and grey bedrock in the upper left.



Figure 5.6. Looking north from Tarla Terrara Hill at the saddle connection Gännäta Maryam village and town (left) to Tabot Madera (right) and Agay Midir (above). To the bottom left, the saddle descends to a gully head forming along the side of the gully extending up the slope while bedrock and a rill can be seen to the bottom left.

Roads have similar but more serious impacts on erosion compared to footpaths by designing or unintentionally encouraging larger catchment areas. Studying roads in the western United States, Montgomery (1994) confirmed predictions that roads would concentrate overland flow and increase catchment area through the use of artificial drains. In turn, these reduce the threshold for gully formation, thereby accelerating their appearance and establishment. Ogbaghebriel and Brancaccio (1993: 104-105) also point out examples of gullies apparently induced by road construction in the Ethiopian highlands, specifically on geological pediments. Nyssen et al. (2002) have considered Ogbaghebriel and Brancaccio's observations and applied Montgomery's findings to study gully formation and evolution along the Makalle-Adwa road and branches in Tigray. In their research, two segments of road were considered. One research area followed the main road through an area where gullies had previously been nonexistent. Since road construction, 16 gullies had formed within the 6.5 km study area, where topographic slope was relatively low (average:  $8.5^{\circ} \pm 6.3^{\circ}$ ). In their second research area along a road



branching from the Makalle-Adwa road running over a course of steeper geological terraces (average slope:  $14^{\circ} \pm 8^{\circ}$ ), gullies were previously extant, and their morphology was compared to changes induced by road construction and land-use changes. In both instances, the roads had been built near the upper portions of the catchment area they passed through, where flow concentration and volume were low, with the idea that this would improve road quality and durability. In the first study area, local informants noted that within a year of road construction, gullies began to form. Their study showed that the paved road surface and construction of runoff, culverts and drain pipes concentrated the previously dispersed flow, increasing the catchment volume. In one of the most severe cases, catchment had increased from 0.1 hectares to 8.6 hectares, causing one of the largest gullies in the study area to form. Proportionate growth of catchments where gullies were already extant were not studied. Besides the increased catchment, Nyssen et al. noted that the placement of drains and pipes also influenced gully formation when they were placed beyond the natural thalwegs and low spots in the landscape. In the first study area, nine gullies formed immediately adjacent to the culverts while the remaining seven formed between 100-500 meters downslope. Significantly, in at least one instance, a previously extant gully in the second area was largely deactivated by changes to the drainage catchment. Nyssen et al. also pointed to land-use as a significant contributing factor to gully formation. While they did not assess the direct correlations between land-use and gully formation, land use was noted. They argue that land uses of all types like plowing, grazing and trampling, and road construction all reduce the topographic threshold for gully formation. Any single factor alone may be sufficient to initiate gully erosion, but a consideration of the aggregate of impacts by land-use across the whole catchment are more important to understanding erosive processes and landscape degradation than the analysis of a single process in isolation.

### **5.5. Formation processes at Gännäta Maryam**

Based on the assembled data above and in previous chapters, it is possible to begin making sense of the muddled and largely eroded landscape around Gännäta

Maryam. Without foreknowledge of what originally produced the archaeological deposits or their distribution *in situ* prior to disturbance, it is difficult to say with confidence how they have changed. However, based on research into environmental changes in the area, it is possible to at least propose why they have preserved so badly, and what changes they may have undergone. There are numerous ways to organize such an analysis, but perhaps the most logical way is to divide the study area into smaller units based on combined factors like topography, pedology, and environmental history, as each of these factors has been shown above to have particular effects on the preservation or degradation of the setting. Thus, the following sections will be organized by shared characteristics, and broken down further when other relevant factors differ across settings. Interpretation of the surface artifact assemblages in light of geomorphological processes will be dealt with separately following the discussion of the broader regional geomorphological processes .

## **5.5. (a) Steep slopes**

The largest well-preserved archaeological contexts studied in the region were along the steep slopes of Kiflie Mado where smithing slag, a hearth, and other domestic and occupational features were found isolated in a small area. As mentioned previously, the site lies on the slopes of a triangular wedge of land formed by the confluence of two steep gullies or ravines. The archaeological features lie along the upper terminus of colluvium on the terrace's scarp accumulated presumably through wash down the slope, above which is only exposed bedrock, loose gravel, and patchy leptic soils. Bedrock could be seen cropping out of the soil in the slag area, though the test unit confirmed the soils could be at least in some areas a minimum of 80 cm deep. A gully bounds the western end of the archaeological area and smaller gullies or perennial rills dissect the fields in some areas. Sometime after the beginning of research in the region in 2009, large ditch-and-banks, fortified with stone and the excavated earth have been constructed parallel with the topography of the slope (Figure 4.8 of Chapter 4). Plow scars in the cultivated areas show plowing is also done parallel to the slope. On the land west of the

large gully, these terracing features have been supplemented with tree plantings and hillside exclosure. Goats herded by local children were observed browsing the open slope on different occasions.

Three archaeological features were identified in the area. Immediately adjacent to the gully to the west is the large wash of ash descending at about 15°. To the west is the field where slag was discovered, where surface collection O and Unit 7 were placed. The slope of this area increased greatly over its extent, being fairly flat, about 5-8° on the upper portion, and increasing to about 15° at the midsection of the lower portion, below what appear to be outcroppings of bedrock. This angle may be slightly exaggerated, however, due to the recent construction of the ditch and bank, which may have undermined the field, causing soil to slide into the space created by the ditch. Distributions of the ceramics and slag show the characteristic pattern of an alluvial fan, probably induced by the slope and retaining ditch. Just east of the slag field past a rill or incipient gully, was the area encompassed by the low wall, either a house foundation or compound wall, where the hearth and living floor were discovered in Unit 8 beneath layers of sterile sediment. It was here excavations revealed an intact domestic hearth and living surface sealed beneath fine laminae of well-sorted sediments washed from ascending slopes. As discussed in Chapter 4, radiocarbon dating, oral history, artifact analysis, and aerial imagery place the date of the production of these archaeological features in the early 20th century, though an earlier date is not out of the question.

Geomorphological processes in this steeply sloping area are clearly dominated by erosion, with aggradations in small, select areas where features like ditches and walls retain eroding sediments. More broadly, the slope may be characterized as weathering-delimited above the archaeological features, where erosive processes appear to be outcompeting soil accumulation or retention, resulting in the dominance of bare rock and absence of artifact and features. Meanwhile, the archaeological area begins the transport-limited zone of the slope. While artifact distributions from the surface collection and alluvial strata in the Unit 8 excavation who evidence for erosion, features like the wall, intentional soil retention features, and possibly fluctuations in topography are actively retaining some soil on this area of the slope. Vegetation clearance and browsing, plowing and trampling are the greatest instigators of water-borne erosion on the transport-limited

area of the slope, but the terracing efforts do appear to play a role in countering these effects. Given the extent of recent erosion control measures on the slope, however, it is difficult to assess how much of the slope's current characteristics are recent, and how extensively they have changed from the recent past. Aerial imagery appears to show that the slope was denuded and possibly cultivated at least since the 1960s, though the erosion control features all appear absent until the 21st century. The presence of such recent features will likely continue to have reverberating effects on the slope as they trap soils and level the slope in the same way the wall around Unit 8 did.

Using the USLE and Hurni's data (1985), less than ideal as it may be, erosion of the slag field prior to the recent modifications comes to about  $13.89 \text{ t ha}^{-1} \text{ y}^{-1}$ ; or, assuming relatively even soil loss to sheet and rill erosion, roughly 1 mm of soil per year (see Appendix C for calculation). If the transposition of soil from loss to accumulation are equal, it would have taken about 500 years to bury the living floor to its current depth; or, about the time of the early terminus of the radiocarbon date up to today. This is almost certainly an overestimate however. Recalling Muche et al.'s (2013) findings that USLE chronically underestimated soil loss by not accounting for runoff, one expects that actual runoff is likely higher than that calculated above, perhaps significantly. The USLE equation also cannot account for other factors. The exposure of mostly bare rock above this local research area almost certainly induced overland flow far greater than on comparable slopes with soil cover, and thus one expects that a far larger volume of water would be introduced to the upper areas of soil on the slope were research was conducted. Likewise, the equation assumes evenly distributed overland flow, not soil loss from flows concentrated into the rills and gullies which dominate the slope. The equation also does not consider soil physically being pushed downslope by plowing as discussed above in Nyssen et al.'s (2000) work. The strata of well sorted alluvium suggest they were deposited in strong overland flow events that lost energy as they descended the slope and ran over the relatively flat area created by the domestic space. Thus, each fine strata is likely representative of a single intense rain event and thus burial time was likely far shorter than the above estimate. Real soil loss is almost certainly many times greater than that estimated above. It is conceivable then that the inundation and preservation of the

house floor under sediment may have taken place in a span counted in decades, rather than centuries.

The other steep slope studied in the research area with clear evidence for soil movement was the cemetery adjacent to Gännäta Maryam Church, where bodies were found nearly exposed at the top of the slope, and deeply buried near the bottom. To summarize, overburden on the slope was primarily rock and gravel, with some soil. Reshaping of the slope by the creation of two retaining walls and the ongoing expansion of the roads has made it difficult to reconstruct the slope's original shape and active geomorphological processes. However, exposure of human remains near the surface at the break of the slope and the overlapped burials covered by colluvium at the bottom of the slope are good indications that the cemetery slope has undergone extensive erosion and/or soil creep, reducing overburden at the top of the slope and redepositing it near the bottom. Radiocarbon dates of the burials are not yet available.

The angle of the slope above the burials is about 30° or more, though it is difficult to determine following the extensive reconstruction of the slope. It also appears to have had a concave profile, leveling off nearer the lowest burials, though again the original slope here is also uncertain. The winding road that cuts the slope twice was only built between the 1960s and 1980s according to the aerial images, and what changes this may have wrought to the slope are not known.

Roughly 80 cm of colluvium has accumulated from the original ground level around the oldest burial mound, including about 50 cm of colluvium over the top of the mound itself. Of this, only about 10 cm or so appears to be recent colluviation, mostly of large rocks likely disturbed by the terracing project. A conservative estimate then is that about 70 cm of soil and gravel, or about 0.7 m<sup>3</sup>, has been deposited over the lower portion of the slope since the interment of the first burial. A USLE estimate for soil erosion in this area using Hurni's data is difficult, as his soil erodibility factors do not specifically describe the loose gravelly colluvium, though they are perhaps closest to Hurni's "Andosol" designation, which he describes as a "black" soil (1985: 666), and which FAO guidelines describe as porous soils of volcanic origin (IUSS Working Group WRB 2014: 137-138). Based on this assumption, the slope might be expected to undergo an annual loss of about 0.76 t/ha/y, a surprisingly low figure resulting from the absence

of plowing, the natural brush cover, and large portion of rocks and gravel. At this rate, making the major assumption that soil accumulation is roughly equal to erosion and barring uneven erosion patterns like rills and gullies, which were not observed on the slope, it would have taken over a thousand year to inundate the burial. Even were MUSLE or RUSLE used instead, the difference of the predictability between the three is not such that the soil loss calculation would likely have produced a radically larger value.

Given the odd orientations of the burials, which were not the typical east-west orientation reportedly the modern convention of Ethiopian Christians, a late first or early second millennium date is not unreasonable as Christianity was probably only in its infancy in the region. However, such a date based on soil loss/accumulation does require number of unsubstantiated assumptions. As the catchment studies discussed earlier (e.g. Hurni 1983; Nyssen et al. 2008) indicate, redeposition from loss does occur locally, but is not a 1:1 equation and soil can move from numerous areas through a catchment before loss or deposition. There is undoubtedly some soil loss from the area outside the church, above the slope where the church forecourt it located. The area is heavily trodden by priests and congregants and covered in loose, dusty soil. The area should thus have reduced infiltration encouraging overland flow, removing the disturbed soil over the hill slope. Furthermore, given the poor consolidation and rocky nature of the slope, slope creep, slumping or other forms of graviturbation can also not be ruled out, particularly if destabilization for burials was a frequent occurrence. The rate of soil creep or slumping, however, is virtually impossible to calculate without further data, as are other modifications to the slope from road and retaining wall construction over the past few decades. Regardless, the superposition of two burials and their complete inundation under colluvium indicates the degree of slope movement and change possible in the research area, whether by human or natural forces, or both.

## **5.5. (b) The hilltops**

The hilltops are a unique and somewhat promising area for research and recovery of archaeological contexts. They were the only other contexts, besides the steep slopes,

to possess intact archaeological deposits and historically they may have been the least disturbed by human intervention due to the preference for limiting their exploitation. On the other hand, their elevated topography makes them unlikely places for soil accumulation over archaeological surface deposits, leaving any such deposit at least partially prone to surface weathering.

As previously described, Tarla Ferrara possessed artifacts beneath the plow zone, though no features were found within the soil. The only features were the large holes cut into the bedrock. Charcoal recovered from the pits provides a date range of the mid 17th to early 20th century. This leaves unanswered the question of whether archaeological contexts have been preserved in the soil, or if the forces of landscape degradation in the area left them exposed to turbation and erasure. It was noted during the final season that the majority of the acacia scrub had been pulled up. The landowner explained that he allowed it to grow, then removed it periodically for fuel wood. In some instances, this event left obvious pockmarks on the soil surface, visually evidencing at least one means by which relocation of artifacts through the soil column might occur. The original interfaces between the bedrock features and the overlying soil, however, were destroyed in the recent construction of the bank and ditch feature. Preservation of the Unit 4 pit features' details as they were cut into the overlying soil strata could have provided some indication of whether soil accumulation had occurred, or whether erosion of the soil was a perpetual and natural state.

On the opposite hill, Alem Doret, the shovel test and subsequent test pit revealed a possible wall feature and tentative living floor on the crescent of land on the northwest edge of the hill. These were sealed under a plowzone that had not been disturbed for more than one agricultural season, at least. The surface area was bounded by a succession of terraced fields toward the middle of the hill, and an older retaining wall around the semicircular slope crest. This may have helped to level out the surface by subsidence of the slope toward the descending wall, burying the features under sediment prior to the more recent initiation of agriculture, though this is merely conjectural.

Both hills showed a thin erosion pavement composed of fine gravel, rocks and ceramic sherds. Erosion pavements are formed by erosion selectively removing fine sediments, leaving behind the heavier soil fraction. This heavier fraction is then

relatively stable under the continuation of the same climatic conditions and provides some protection to the underlying soil from further erosion (Shaw, 1929; Lowdermilk and Sundling 1950; Poesen 2005: 282). Undoubtedly, the clearance of the natural vegetation on the hill disrupted their environmental equilibrium, and encouraged accelerated erosion. The presence of an erosion pavement is indicative of this change in stasis, and suggests any once present surface remains would have been exposed to stronger erosive forces than under protective vegetation, which would have stabilized soil and reduced the volume and energy of overland flow. Additionally, gullies are present on the breaks and slopes of both hills, though they are more prevalent on Alem Doret. These too indicate an unstable, eroding terrain. The further erosion of which will continue to encroach on the soils increasingly higher on the hills' surfaces.

With no counter example examined in the study area, it is difficult to pick out what preservation would have been like under forest conditions, but deforestation has clearly resulted in soil erosion and deflation. On hilltops in Ethiopia's semi-arid highlands where deposition of new soils on the hill surface are likely minimal, this erosion is likely to be detrimental to less durable archaeological features once exposed by deforestation. An ideal setting for archaeological reconnaissance would have little to no obvious disturbance of the natural groundcover. This is an unlikely scenario one might encounter today, however, given the region's historical overexploitation of forest resources. The best preserved wild areas one is likely to find today are the grounds surrounding historic churches, such as the expansive grove of old-growth forest around Yemhrenna Krestos. Such forests are somewhat rare and limited in extent, however, and might pose both social and technical challenges to archaeologists. However, settings like Tarla Terrara may in fact be the next best option. Recalling Mwendera and Saleem's findings regarding differential rates of erosion of select soils (1997), the coarse leptic soils of hills like Tarla Terrara are more resistant to erosion than finer soils, regardless of intensity of use. Such settings then may provide a second-best option for archaeological preservation where extensive vegetative groundcover has long been absent.



### 5.5. (c) Vertic slopes

Vertisol exist throughout Tabot Madera, but are only exposed on the gently sloping sides of the northern half of the study area. Elsewhere, as in the floodplain, they are buried beneath the alluvium. These exposed Vertisols are undoubtedly the least likely places in the study area to encounter intact archaeological strata due largely to their management practices, though their physical properties even under different management practices or in more level settings may pose a threat to archaeological deposits.

Vertisols possess a number of unique characteristics relative to other soils (see Wilding and Puentes, eds. 1988; Ahmad and Mermut, eds. 1996), especially those in the study area. Vertisols are characterized by their high percentage of "swelling clays," causing them to go through characteristic shrinking and swelling phases as they become saturated and dry, respectively. Though Vertisol horizons can form by a number of means, in our study area they have most likely formed from the degradation of the local basalts, either in situ from bedrock or from the erosion of the ascending scarp (Ahmad 1996: 7; IUSS Working Group WRB 2014: 171-172).

Vertisols are characterized by their high percentage of smectite clay and the physical features this grants to the soil (see Mermut et al. 1996). These features include the aforementioned cracking while shrinking, swelling while wet, self-mulching, churning, and sub-horizontal cracking (slickensides) (Mermut et al. 1996: 47-49; Dudal and Eswaran, 1988). As the Vertisols experience wet and dry periods, they can undergo a series of complex feedback processes. Those most relevant to the current project are as follows. During wet periods, water penetrates between the laminar particles of smectite clay, causing the soil column to expand, exerting pressure in all directions on neighboring particles. As the soil dries, typically faster near the surface, the particles pull closer together, causing vertical cracks to form near the surface. The differential pressure put on the soil column as it dries can thrust soil up, while surface soil, and potentially artifacts, falls back into the cracks, resulting in the process known as "self-mulching." Under conditions of low intensity rainfall, the soil surface will absorb most of the water, causing the tops of the cracks to close, resulting in unstable subsurface tunnels. Alternatively, high intensity rainfall can inundate the cracks. In either instance, the

cracks or tunnels can channel water, increasing localized flow volume and energy, providing for ready-made rill formation. As discussed above, Vertisols already have relatively low infiltration capacity, which one expects can be reduced further by compaction from trampling and rain splash. Relative to their leptic and cambic neighbors in the study area, then, Vertisols in the area would seem to be at much greater risk of sheet and rill erosion. Naturally, the repeated shrink-swell events of Vertisols can produce "nutty structures," small nodules of clay covering the surface. Plowing prior to rainfall without protective groundcover also produces a loosely aggregated soil surface. Combined with their propensity for rill and sheet wash, there is a ready supply of soil to be easily wash away in heavy overland flow events. The local presence of the Vertisol plowzone over the densely packed Vertisol subsoil horizon also likely produces a strong differential in absorptive capacity, only further increasing the likelihood that overland and throughflow will affect the plowzone soil more strongly than on other, more porous soil columns. Management practices like those employed at Gännäta Maryam for the cultivation of Vertisols, particularly the extensive plowing prior to the rainy season, and the delay in planting, is a sure means to induce heavy soil loss.

Direct application of Hurni's USLE system is challenging here because of poor definitions. Regarding groundcover, two variables are possibly applicable. On the hand, the field is planted with pulses, in which case the USLE estimate is a low  $7.5 \text{ t ha}^{-1} \text{ y}^{-1}$  about the same as Nyssen et al. estimate is also lost on average by plowing under general conditions in Ethiopia (2000; also Gebremichael et al. 2005). On the other hand, this likely assumed such a groundcover during the period over which most of the erosive rainfall will occur. As is told by the resident farmers, however, the fields are left plowed, but unplanted until after the rainy season begins to ebb. In that instance, the variable for "fallow ploughed" is perhaps more accurate, resulting in a very high soil loss estimate of  $29.9 \text{ t ha}^{-1} \text{ y}^{-1}$ , more similar to Hurni's (1986) estimate of soil loss on the steep fields of in the Semien Mountains:  $42 \text{ t ha}^{-1} \text{ y}^{-1}$ . Given the shortcomings of the USLE equation and its inability to account for local factors like tillage displacement, soil loss by rills and gullies, and the possible effects of the unconsolidated plowzone over the dense subsoil, real soil loss is almost certainly higher than  $7.5 \text{ t ha}^{-1} \text{ y}^{-1}$ , and perhaps exceeds  $29.9 \text{ t ha}^{-1} \text{ y}^{-1}$ . A conservative estimate, then, would be that soil loss from the Vertisol slopes is

probably around 1-2 mm of soil per year, if not higher. In the long term, this would mean at least a centimeter or more of surface horizon lost at least every 20 years, not counting the additional soil lost by rills and gullies.

This erosion pattern in this setting is clearly an example of weathering-limited denudation. The area of Surface Collection A has no general source from which to derive a significant volume of sediment for redeposition, the saddle being rather rocky and bare having already been eroded down to the regolith over most of its extent. The vertic fields are all dissected by gullies and permanent fluvial channels leading into the main wadi. As previously mentioned, it is theorized the plow zone is refreshed by scraping up the underlying Vertisol clay horizon. Thus, any surface deposits would remain exposed to the elements, and, even without disturbance by plowing, would suffer from erasure by erosion within a few centuries. Older features like that of an early medieval royal encampment, would not survive as visible surface features. Elsewhere, considering Nyssen et al.'s (2015) sediment budget study it is not unexpected that at least a small portion of this eroded Vertisol would be deposited on the alluvial plain, perhaps where Vertic soils are seen on the terraces fields over non-vertic alluvial strata.

### **5.5. (d) The sloping margins of the alluvial plain**

Along the lateral margins of the alluvial plain are the gentle slopes and terraces separating the plain from Tarla Terrara and Alem Doret hills. The western side of the plain was devoid of artifacts. The area is dominated by a gradual transition from a more vertic surface soil in the north, to a coarser, more leptic or cambic soil to the south. A shovel test toward the north (VS 6) in an uncultivated field revealed a depth of soil only about 15 cm before transitioning to a dark, friable bedrock. Further south, the soil was far deeper (VS 5), about 55 cm, before transitioning to friable bedrock suggesting the area is perhaps a pediment to the upper terrace and hill. In this latter instance, the bedrock was visually similar if not identical to that on Tarla Terrara hill, though the soil was finer and better developed, being more similar to a Cambisol than the leptic soil on the hilltop. Reviewing Figure 4.2, the slopes are distinguished from the alluvial plain by

a gully separating the two, with feeder gullies cross-cutting the slopes running up to the adjacent terrace skirting Tarla Terrara. In addition to the gullies, the satellite imagery appears to show fans of alluvium eroding from the terrace onto the slopes. All these features suggest an actively eroding landscape. While sediment transport to the area is clear, removal by the gullies, as well as sheet and rill wash, is likely outcompeting it, evidenced by the very shallow soil from VS 6. Such erosion may once have been even greater, as evidenced by the rills seen in the aerial image from the 1960s, now removed by modern erosion control measures. Thus, similar to the vertic slopes, these denuded and cultivated, gently sloping areas are suffering under a great degree of soil loss and may partially contribute to the absence of artifacts there. However, despite the erosion, it is also entirely possible that the areas were simply not used for activities or disposal of materials that would leave an archaeological trace, even under ideal conditions.

The eastern flank of the plain, however, possesses a slightly different picture. The fields here are well-established bench terraces, some risers rising above the fields below them by a meter or more, giving all the fields a more level grade than the sloping fields on the western side of Tabot Madera ( $<4^\circ$ ). In this area, some artifacts were found in the northern area. Again, gullying was present, though primarily limited to the slopes of Alem Doret. These gullies in some instances left alluvial fans of fine to gravelly sediment. The soils seen here in the shovel tests appear deeper than those on the western side, exceeding the possible depth of our shovel tests. While artifacts were present, there was no stratigraphy beneath the plowzone discernible with the shovel testing method. It is possible stratigraphy does exist, but was too fine or subtle to be detected. Very likely these bench terraces have effectively been retaining soil against significant loss over the course of their existence, growing from the accumulation of material washed from the hills. Even as erosion has occurred, the leveling effect on the fields may have reduced the energy of sheet and rill erosion compared to the sloping Vertisol fields and western fields of the plain, preventing, or at least reducing the loss of artifacts. Their presence in the area, however, is not necessarily in their primary context. Without discernible stratigraphy it is difficult to locate their origin, though they may have washed from Alem Doret, or been discarded as refuse from now absent working and living spaces.

Continuous heavy plowing of the fields each season may be the reason for the absence of stratigraphy.

### **5.5. (e) The alluvial plain**

The alluvial plain was productive in terms of artifact recovery, but fruitless for the discovery of archaeological contexts. However, this may in part be the result of methodological sampling. To summarize Chapter 4, shovel tests in the eastern plain retrieved artifacts at depths extending to the limits of shovel testing and noted some possible changes in soil composition. However, with the rough methods of shovel testing, absolute changes in stratigraphy could not be seen in the narrow hole or clearly distinguished from soil in the shovel. Wall profiling failed to discern any stratigraphy on the eastern bank. Observations in the wadi showed, however, that alluvial stratigraphy clearly composed the majority of the soil column in at least some sections of the western profile. The uppermost layer was largely a dark vertic soil contrasting strongly with the paler, finely graded sediments through the rest of the column. General stratigraphy across both sides seems to show a bedrock foundation overlain with Vertisol clay, followed by alluvium.

The shovel tests in the eastern section suggest that stratigraphy was perhaps present, though not distinguished or thick enough to be readily observed in shovel testing. It was hoped wall profiling of the wadi would be a quick way to examine possible stratigraphy and test for *in situ* archaeological material, though nothing was recovered. One possibility is that while alluvial strata have been deposited across the floodplain, human intervention in maintaining the wadi's banks and natural processes such as the backfilling of the old channel as the meanders travel has erased alluvial strata in many areas. Testing and sampling methods used were thus inadequate for the situation. A test unit set further into the eastern field would have been more time consuming, but ultimately may have been more effective for evaluating the area's archaeological potential.

On the western side, horizontally bedded and planar or near-planar alluvial strata are very distinct (Figure 5.7). However, numerous thorough examinations of the wadi profile failed to identify any artifacts within the wadi walls. Intrusive studies could not be conducted on the western bank because permission to work there could not be acquired. Three possible means might explain the presence of these strata. If Billi's (2008) theory about hyperconcentrated flows producing the planar sediment deposits is correct, presumably the energy of the alluvial events that produced them would be sufficient to disturb most materials in archaeological contexts they washed over and/or transport artifacts like the ceramics recovered on the eastern side from elsewhere. This does not mean however that all archaeological contexts would be destroyed completely. Potentially heavier materials like stone features (e.g. *tukul* or *nas* foundation walls and hearth rings), pits or other depressions, and high rises, might be swept over and inundated in sediment, causing damage but being afforded some protection as the sediment accumulated over them while the flood ebbed. Alternatively, if the majority of the force of the hyperconcentrated flow was restricted to within the wadi, the water flooding over the banks would have carried significant sediment, but had far less energy. In this lower energy environment, archaeological strata may have fared better than if they were scoured by the concentrated force of the flood, causing much less disturbance along with the sedimentation. Alternatively, at least some of the strata may be the result of erosion from the surrounding slopes accumulating over the plain in large wash events, though this probably does not account for the entire accumulation of strata in this area.



Figure 5.7. Comparison of the eastern (left) and western (right) wadi profiles in the alluvial plain of Tabot Madera.

Regardless of the cause, it is interesting to note how well the strata are preserved, and how distinct the vertic soil on the surface is. The well-maintained and continuous profile of alluvial strata would preclude the possibility that the area had been plowed, because such a practice would erase the strata. Meanwhile, the thick cap of vertic soil over the grittier alluvial strata suggests transport and deposition of the Vertisol at a much later date, close to the present, or else a recent regime of high-volume, low energy overbank flow where only the finest sediments remained in suspension for deposition. Perhaps the vertic accumulation is an indication of the time since the intensity of agriculture became sufficient to erode Vertisols higher on the plain, depositing them in this context instead. The time period represented by the intact alluvial strata would correlate with a period before the intensity of agriculture was sufficient to degrade the landscape, and before plowing in that area would have disturbed the fine strata. It seems unlikely the vertic topsoil could be autochthonously produced, as illuviation would cause the clay to migrate downward through the soil column, through the coarser sand and silt below it. Thus, there is the possibility much of the alluvial strata is either devoid of

artifacts, at least from the time agriculture was practiced, or that the intensity of land use was not sufficient to radically disturb the region's geological balance with its environment. Despite the absence of discoveries of undisturbed archaeological deposits in this area then, the potential for finding them is higher than or at least as good as many other areas within the study region. Simply put, better research methods, such as test excavations with the width and care to identify alluvial and other strata must be undertaken rather than shovel tests.

### **5.5. (f) Pediments**

The pediments, or possibly, though less likely colluvial slopes, around the base of the scarp were not studied in detail in this project. This was because surface artifacts were not found along them in walking surveys, and it was presumed erosion would have removed or disturbed them. However, in retrospect, they may be worth a reexamination. The pediments in the study area are similar to the eastern slopes separating the alluvial plain from Alem Doret. They are defined by numerous fields divided by bench terraces, and, despite the gullies dividing them from the scarp, show evidence for the collection of colluvium and alluvium derived from the ascending scree and scarp. Like the margins of the alluvial plain, then, it is possible the leveling effect of the bench terraces has slowed the rate of erosion on these surfaces, and the accumulation of material washed from above may have helped inundate and protect archaeological material there. However, the chances of this may be slim, as even residents reported never or only very rarely encountering artifacts in this area, unlike others.

An alternative is that the pediments were only opened up to human exploitation relatively recently as population pressure drove the expansion of cultivated land. Sensibly, farmers in the study area prefer the deep, fertile, and well-watered soils of the alluvial plain, and recognize the benefits of the vertic soils for select crops. Potentially the pediments with their steeper slope and rockier composition were not preferred for agriculture until, like the hills, population pressures drove people onto less and less desirable land. Thus, the absence of material remains may alternatively be due to a



general absence of human use of this terrain until the fairly recent past. Regardless, given how deceptive the region is in its presentation of archaeological material, versus its degree of preservation in those areas, in future further investigation of pediments is warranted. They may have only recently come into use, or like the vertic slopes, they may be too prone to erosive forces for good preservation, or, like the areas abutting steep slopes, they may be ideal settings for the accumulation of soil over archaeological contexts, particularly when protected by features like bunds and packed-earth benches.

### **5.6. Discussion of formation processes at Gännäta Maryam and their relevance to archaeological research there**

The above analysis of formation processes in different environments shows how naturally occurring erosion is exacerbated by anthropogenic features. By the same token, however, some anthropogenic features like the terrace walls can also affect erosion processes to the benefit of some archaeological contexts. The general trends observed here are that areas of soil instability induced at least by deforestation leads to erosion. Upslope or elevated areas in a catchment, where weathering limited denudation is likely to be greatest, will eventually suffer severe degradation of archaeological contexts as soil loss continues. Downslope areas in a catchment, however, where transport limited denudation is likely to be greater, may be the most likely areas to find preserved archaeological contents. The possibility of preservation or degradation and the rate of degradation, however, are strongly conditioned by natural and anthropogenic landscape features like walls, bedrock or vegetation and each setting must be considered in its wider context. Paradoxically, surface surveying is also perhaps the least effective means of identifying archaeological contexts for research. In all instances where surface artifacts were assumed to represent the presence of subsurface archaeological contexts, it turned out that the presence of those surface artifacts was the end result of detrimental site disturbance processes. This is likely due to the thin soils and already high baseline erosion rate in most areas where perennial vegetation/absence of plowing is not present. By contrast, areas where surface features provided no clear indication of subsurface remains were often those areas that had preserved archaeological features the best. This

was inevitably due to erosion of soil elsewhere and extensive redeposition of those soils over the archaeological contexts, usually due to topographic contrasts or barriers differentiating the area of deposition from soil loss.

In conclusion then, the use of surface artifacts as a means of identifying areas for archaeological research is likely misguided if well-preserved contexts are the objective. However, the rarity and challenges to identifying sub-surface remains where no visible surface materials might indicate their presence means that future researchers may have to supplement their research with data gathered from surface remains. As such, understanding how erosion processes, plowing, and other common processes affect surface artifact scatters is essential.

### **5.7. Plowzone processes and surface archaeology**

Following the discussion of landscape formation processes in the research area discussed above, it is clear that erosion is the primary force active on archaeological contexts in the region, with only isolated exceptions. The general pattern observed is that in areas where erosion is the dominant force, archaeological features do not preserve well. Thus, much of the area's archaeological contexts are surface assemblages and the surface assemblages frequently appear to be the result of or evidence for the dominance of erosive processes over depositional ones. The role of plowing in further disrupting these archaeological assemblages cannot be ignored; it seems the need for agricultural land, resulting in deforestation and intensive land use, is in fact the foundational element driving the strong and detrimental forces of erosion in the study area. Thus, the effects of plowing ought to also be considered when discussing the surface assemblages, as it too undoubtedly affects the surface archaeology in tandem with erosion. The argument to be made below is that plowing obviously affects artifact distribution and thus site interpretation; however, the resulting pattern is determined largely by factors such as slope and erosion features, not plowing alone. In the absence of contexts preserved *in situ*, plowzone archaeology may be the best option for studying highland sites and so

understanding how the archaeological context of surface remains has been affected is important to future research.

### **5.7. (a) Topography and plow soils**

While erosion has certainly taken its toll on the integrity of archaeological contexts in Ethiopia, the substance of this chapter ought to have made clear that plowing and the need for agricultural land largely underwrite the erosive processes that have been observed. The following section will examine literature on the effects of plowing and local conditions such as slope and erosion features on artifact displacement. This data will then be applied to the surface collections at Gännäta Maryam described in the previous chapter to show that artifact displacement does indeed appear to correlate with the expected effects of both plowing and erosion.

Surface assemblages have long been recognized as valuable archaeological contexts despite their disturbed nature (e.g. Binford et al. 1970; Redman and Watson 1970, Dunnell and Dancey 1979; Lewarch and O'Brien 1981a). Steinberg (1996) has characterized such surface assemblages not as sites, but as "site signatures," acknowledging the disturbed and frequently unrepresentative nature of the surface assemblages, but recognizing their significance for understanding the archaeological contexts from whence they originated. Quantifying the effects of plowing in particular has been of interest since the trend in studying formation processes began (e.g. Roper 1976; Lewarch 1979; Lewarch and O'Brien 1981b; Ammerman 1985; Odell and Cowan 1987). While much such research has been interested in using surface remains to identify or characterize subsurface features, the Gännäta Maryam data dismisses the need for this type of research. Rather, the focus in contexts like Gännäta Maryam must be on understanding formation processes in the plowzone and what aspects of the original assemblage have possibly been lost or what can be gleaned from such an imperfect reflection of the primary contexts from whence they originated.

Lewarch (1979) provides a good summary of the objectives of understanding how plowing affects archaeological surface remains and the factors involved, in addition to an

extensive summary of previous research. Understanding displacement, of course, is the primary concern, though this takes place in three primary directions: parallel and alternately perpendicular to the direction of plowing (Lewarch and O'Brien 1981b: 29), and vertically through the plowzone. The first two are frequently lumped together as merely lateral displacement, as movement along both x and y coordinates is typical, particularly with certain plow designs like moldboard plows (Lewarch 1979: 107). Controlling factors include the soil type and moisture content, slope of the field, direction of plowing, and type of plow. Displacement of individual objects within an assemblage is affected to some extent by size, shape and density, though as will be discussed, the relevance of these factors and how greatly they influence movement does not appear well understood, yet.

Lewarch's (1979) summary of trends observed by previous researchers regarding these factors is as follows. Plow instrument is important because different plows move soil differently. As discussed above, implements like moldboard and disc plows uplift and turn over soil, while the ard plows like those used in Ethiopia merely rake and "shatter" the soil mass (Lewarch 1979: 104 citing Kepner et al. 1978: 113; Gebregziabher et al. 2006: 133). By the physics of their operation on soils, plows like disc plows may also displace more soil behind the plow as it passes than other plows that naturally push soil in a more forward direction. Unfortunately, as most of the literature seems concerned with areas plowed in or using technologies from modern or historic Western systems, much experimentation and study has been based on the effects of historic or modern plow types like moldboards and discs (e.g. Ammerman 1985; Odell and Cowan 1987; Steinberg 1996; Navazo and Diez 2008). A respectable body of literature on ard plows does exist (e.g. Kouwenhoven and Terpstra 1970, 1977, 1979; Fleur 1987; Goe, 1999; Gebregziabher et al. 2006, Nyssen 2000), though the utility of some of this literature is limited because the studies focus on soil and agriculture research, and thus sometimes lack direct application to archaeological problems. Nonetheless, Lewarch (1979: 109) argues that displacement by tined plows like ards is only smaller than that by plows like moldboards by a few centimeters per pass.

Slope is relevant because of its affect on displacement distance. Nyssen et al.'s (2000) study, discussed above, is the most relevant as it was conducted in Ethiopia using

the traditional *maresha* plow. In general, they found that on level slopes, displacement is greatest parallel to plowing. As slope increases, the distance of parallel displacement declines while perpendicular displacement increases greatly, though with great variability among individual objects compared to the more regular parallel displacement. In a small experiment, Navazo and Diez (2008) observed that plowing along the contour of their sloping field resulted in limited perpendicular displacement down slope. However, after numerous seasons of observation, they inferred that in one of their final collections, the farmer had driven his plow down the slope of the field, resulting in far greater displacement down slope than seen previously.

Soil composition and moisture are relevant because different soils may behave differently under plowing. Lewarch (1979: 110) points out clay soils in particular, because they are more likely to aggregate in clumps and stick to the plow mechanism, dragging artifacts contained in the clumps or those that come in contact with the clumps longer parallel distances than might occur otherwise in more friable soil. Moisture, of course, can increase the tacky quality of such soils. While certainly something to keep in mind when considering artifact displacement in Ethiopian soils like the vertic soils compared to the friable leptic soils, the small surface area and volume of soil displacement induced by the ard-style plow seems unlikely to drag as much soil behind it as plows with larger surface areas.

Literature on the significance of artifacts' size, density, and shape relative to the length of their displacement is varied. For example, Lewarch (1979: 114-115) compares the research of Roper (1976) to Robertson (in Talmage and Chesler 1977). Roper examined the displacement of fragments of large bifaces that had presumably been incorporated into the plowzone for decades or longer, while Robertson was recording the movement of halved bricks laid down in a considerably shorter controlled study. Roper identified an average displacement less than 2 meters, while Robertson's measures were in excess of 2 meters. Lewarch argues that the discrepancy in measures has to do with the size and shape of the objects measured. The bricks, he argues, are quite large and blocky in a way plowzone artifacts are generally not. The blocky shape lends the artifact different flow qualities in moving soil that would not be expected of smaller, more irregular artifacts like the biface fragments. Furthermore, the biface fragments, he

argues, are likely more representative of expected average displacement because they are in real-world artifacts. Likewise, Odell and Cowan (1987: 469) compare their results, which confirm the trend that on level surfaces, artifact displacement parallel to the direction of plowing is greater than perpendicular to it, to that of Nichols and Reed (1934), who found the opposite. Whereas Odell and Cowan, however, had used lithic materials from knapping experiments, Nichols and Reed used wooden blocks. Like the bricks, they argue that the wooden block's low density, large size, and chunky quality grants them different flow qualities in the moving soil, and that such objects are not representative of artifacts found in plowzones, unlike their lithics.

In Lewarch's (1979: 106-116) summary of studies on net artifact displacement, the consensus of research appears to be that average lateral displacement is about 2 meters, though outliers may move significantly further. The greatest distance of movement is in the direction of plowing, though as subsequent plowing might contact an artifact coming from the opposite direction than during the previous plowing event, or drive neighboring artifacts in different directions, there does not appear to be a unidirectional bias to artifact displacement. Studies like Lewarch's (1979: 138-139), Lewarch and O'Brien's (1981b), Odell and Cowan's (1987), Nyssen et al.'s (2000) and Navazo and Diez's (2008) all report similar results, except in the latter's during the one instance plowing was done down slope. In Lewarch and O'Brien's (1981b) study, which controlled for horizontal movement of different artifact size classes, they also conclude that smaller artifacts move less distance on average than larger artifacts. Finally, Lewarch (1979: 116) concludes, as do Odell and Cowan (1987: 481), that the ultimate distribution pattern is stochastic. Thus, overall, horizontal artifact distribution where tillage is the primary force moving artifacts will tend to moderate toward a random distribution of any given artifact without clustering if the original distribution was even and the extent of total assemblage distribution will not greatly exceed the size of the original locus of deposition.

Unfortunately, vertical distribution biases the surface assemblage more greatly than horizontal distribution. Here, factors like size, shape, and density do appear to play some role (Lewarch 1979: 117). Lewarch (1979: 117-122) notes that most research on vertical sorting up to the point of his writing has come from tillage engineers rather than

archaeologists. Their research seems to confirm that size is the most important factor, and that in mixing dry masses of blended material, smaller artifacts tend to percolate through the medium while larger artifacts either rise, or resist downward movement due to their large surface area. Archaeological research on artifacts or simulacra confirms the research done by tillage experts on the size effect (Baker 1978; Lewarch 1979: 135; Lewarch and O'Brien 1981; Odell and Cowan 1987). Lewarch argues shape (1979: 119) also plays a role, but bemoans a lack of research in this direction. He argues objects with broad or blocky sides are more likely to be dragged or caught up in plowing and thus thrust up to the surface more readily than more regularly rounded objects. Studying subsurface movement of lithics in uncultivated land in central Africa, Cahen and Moeyersons (1977) find that the relative dimensions of artifacts does play a role in percolation through soil, though they were observing natural processes in undisturbed soils rather than plowzones. Likewise, Frostick and Reid (1983) also note that the shape and dimensions of vertebrate fossils appears to control their movement across sloping surfaces, resulting in fossil sorting. While neither study was conducted on plowzones, both suggest that artifact dimensions would be likely to have some role in artifact sorting through a plowzone since they are relevant factors in other conditions.

The result of this vertical sorting is that larger artifacts do tend to be disproportionately represented on the plowzone surface compared to smaller artifacts. Overall, theoretical and experimental consensus appears to agree that surface artifact population is less than or equal to about 10% of total artifact assemblage contained in the plowzone (Lewarch and O'Brien 1981b; Ammerman 1985: 39; Odell and Cowan 1987: 480; Navazo and Diez 2008: 331). While surface assemblages can represent a broad sample of the assemblage, then, it is not necessarily an representative sample.

Plowing alone, however, is not the only factor in artifact distribution, particularly in geomorphologically active settings like the study area. Lewarch (1979: 116) does give credit to the possible natural effects of relief and erosion process in affecting plowzone material distribution as much as plowing alone, though few experiments in archaeological contexts appear to examine the effects of these variables in agricultural settings. Rather, such experimentation comes from agricultural and geological sciences (e.g. Poesen, 1987; Nyssen et al. 2000) and archaeological contexts in uncultivated settings (Rick

1976; Cahen and Moeyersons 1977; Frostick and Reid 1983; Wainwright 1992, 1994). As will be discussed, while plowing may produce a randomized, even distribution of artifacts, albeit unrepresentative of the whole assemblage, natural forces may sort artifacts or produce patterned concentrations of artifacts related to topography and erosion processes.

The most basic natural factor influencing artifact distribution would seem to be slope and it should be expected given the discussions above that greater slope correlates to increased potential of graviturbation by colluvial or alluvial processes. Rick (1976) conducted controlled surface collections down a slope descending from a rock shelter site in the arid highlands of Peru where it appeared that certain artifact classes had concentrated at different points along the slope. The slope began at about 30° near its apex and declined to about 15° near its foot, with an average slope around 20°. They hypothesize that fluvial processes, were they responsible for artifact migration, would entrain smaller and lighter artifacts like bone fragments, concentrating them lower on the slope than heavier artifacts like lithic cores. Alternatively, were gravity the primary process, larger and/or heavier objects would be more likely than smaller or lighter objects to tumble down the slope, due to their higher kinetic energy and capacity to overcome the friction imposed by the slope. Consequently they found that indeed, heavier objects concentrated down slope where slope angle declined sufficiently to dissipate the objects' kinetic energy, while bone remained concentrated upslope. They also note, however, that bone remained densely concentrated, perhaps being closest to the locus of its discard, while ceramics and lithics were comparably less concentrated, becoming trapped along their travel downslope by impediments like vegetation, sorting by size and mass, and presumably general dispersal of the total assemblage over distance. They confirm then that colluviation was the primary process of downslope movement rather than alluviation, as they had suspected in the arid environment.

Wainwright (1992; Wainwright and Thornes 1991) conducted fluvial experiments and models examining the effects of overland flow and confirmed that under fluvial conditions, artifacts move similar to other material like rock and soil in alluvial regimes. More intense rainfall results in greater overland flow, entraining larger and heavier materials. Lighter materials may remain in suspension longer than heavier materials



down a slope of decreasing angle. Alternatively, the cessation of the overland flow event by infiltration of the water or the stoppage of the rain may produce a heterogeneous wash of previously suspended material. Regarding the actual distance of artifact movements, however, their experiments resulted in a generally stochastic pattern (Wainwright 1992: 232). This variability of distance traveled was due to controlling factors such as the dimensions of the objects, characteristics of the soil and bed surface, and aspects of the flow.

Working in Koobi Fora, Frostick and Reid (1983; also Reid and Frostick 1985) conducted a similar experiment to Rick's (1976) examining the movement of vertebrate fossils and lithics on a retreating slope, though in their case, with an arid environment punctuated by two annual rainy seasons, both colluvial and alluvial processes were expected. However, it should be noted the reported annual rainfall at the site was 1/3 the volume of rain in the Gännäta Maryam study area and was broken up over two rainy seasons. As already described, they found that shape played some role in artifact movement. Discoidal lithics and flat fossils like cranial fragments were less resistant to movement than round or linear bones. However, they found that this pattern was only maintained among similarly sized and weighted objects. Large objects like the long bones of megafauna moved down slope significantly faster than smaller fossil long bones. Importantly, the majority of the experiment was conducted on slopes averaging about 30° and the pattern observed conforms to Rick's observation of sorting whereby larger artifacts move down slope more readily than smaller objects. In the limited instances where slopes were 10° or less, fluvial erosion appeared to dominate. Objects larger than 0.8 cm remained largely unmoved, while soil and smaller fossils eroded away from around them.

Other fluvial processes, however, were also active in Frostick and Rick's experiment (1983). Rills ran through some of the research area and they observe that water flow in the rills undermined the sediment beneath the artifacts and accelerated the down slope movement of the fossils relative to adjacent fossils on normally sloping ground. More direct study of rill-induced object transport has been undertaken by Poesen (1987). In his experiment, hundreds of flint cobbles and fragments of various shapes ranging in intermediate diameter from 0.35 to 9.8 cm were labeled and placed in transects

across four rills on an unvegetated agricultural slope, while smaller pebbles with a maximum diameter of 0.8 cm were placed between the rills. Rill bed slope ranged over their courses between 5 and 20°. The distance each flint moved was recorded after a 30 mm h<sup>-1</sup> rainfall event lasting 12 minutes, smaller and shorter than average rainy season rains in Ethiopia (see above). Following this rain event, the pebbles placed between rills moved a maximum of 5 cm, which Poesen attributes to splash- and runoff-creep, arguing that overland flow volume would not have been strong enough. By contrast, even pebbles as large as 9 cm in diameter were entrained at gradients of 6° and higher within the rills, where discharge was concentrated by the accumulation of water from the watershed into the rill. Overall distance traveled compared to size is reported to have varied widely though is not directly reported, though the correlation coefficient between diameter size and distance moved for various transects is. The correlations are poor, frequently 0.5 or less, though this disjuncture between size and distance appear to agree with Wainwright's findings cited above. However, based on graphs provided, at slopes between 14-15°, stones with a diameter of 1-3 cm moved as much as 90 cm, while stones as large as 7.5 cm moved 10 cm. Considering that few surface artifacts recovered from Gännäta Maryam exceeded 3 cm, the potential for dispersal by rill wash away from their original locus is great.

It may also be relevant to note a finding by Kirkby and Kirkby (1976) regarding erosion of surface material on retreating slopes. Though they were studying artifact dispersal from eroding house mounds, the point is quite possibly relevant. They note that as the slopes of house mounds erode, sherd concentration initially builds up near the base of the mound (Kirkby and Kirkby 1976: 239). Presumably this is an effect of the movement of sherds down the diminishing mound slope where they aggregate. They report, however, that this aggregating effect only lasts for 50-100 years, after which further process will continue to disperse the surface remains. As will be discussed, this lesson of undercutting and aggregation may be relevant to explaining the dense accumulation of sherds seen at the heads of the gullies in the surface collections.

**5.7. (b) Plowing, erosion, and artifact patterns in the shovel tests**

The following table (Table 5.5) divides key surface collections by their slope and examines the relationship between slope and artifact distribution. Overall, shovel tests were conducted either on generally level surfaces ( $\leq 3^\circ$ ), surfaces with gulley or rill erosion features, and surfaces with an overall steep slope sufficient to initiate rill erosion and graviturbation ( $\geq 4^\circ$ ). As the table shows, artifact distributions in these settings mostly conform to expected patterns, though it highlights the roles other processes and methodological biases may play in interpreting artifact distributions.

Table 5.5. Table of surface collections and their artifact patterns related to slope, descending from collection areas with steepest slope to least slope. "Artifacts" refer here to ceramics. "Level" refers to slopes less than 2°. Collection J is placed at the bottom as an extreme irregularity among the surface collections.

Surface collection	Slope	Artifact distribution	Interpretation
O	5-8° increasing to ~15°	Small and large artifacts concentrate downslope, though small artifacts more than large	This pattern conforms to displacement by both water and gravity, the latter probably accelerated by plowing. Undercutting of the slope may also play a role.
A	6° slope with incipient gulley head formation $\leq 12^\circ$	Clear concentration of all sherds in erosion feature	Fluvial and possibly colluvial erosion exacerbated by plowing are concentrating large artifacts in depression. Undercutting is also likely involved.
D	5° slope with 10° erosion feature head	Artifacts appear to concentrate on steep slope and flat area beneath	This pattern conforms to undercutting concentrating artifacts, though count is small and pattern may be random
B	Irregular, 4°-4.5° in northern half, depression in middle	Artifacts are concentrated on descending slope in northern half	Artifact concentration does not conform to expected patterns. Pattern may instead be a result of collection grid placement near edge of distribution focused around collection A
E	4.3° increasing slightly toward northeast end	Large artifacts evenly distributed; small artifacts concentrated around lowest elevation	This pattern conforms to displacement by fluvial processes
N	Median 3.75° being more level to the northeast and steeper to the west and southwest. Recall the bedrock exposure and bund along the southern edge	Large artifacts concentrated along western and southern peripheries, evenly distributed. Small artifacts strongly concentrated along southwest and rocks	This pattern may conform to erosion by water, concentrating smaller artifacts around the rocks. Alternatively, soil loss may be greatest around rocks, exposing ceramics. Concentration is likely skewed west for both types by placement near southern and eastern margin of terrace and artifact distribution
G	Level across center, corners descending ~4.3°	Small artifacts evenly distributed. Large concentrated around corners	Unusual pattern. Undercutting of sloping margins may have concentrated surface occurrence of large sherds while removing some

			smaller sherds. Alternately, anthropogenic processes like trampling or plowing may be pushing large artifacts towards margins.
F	$\leq 2.3^\circ$	Even distribution of sherds	Pattern conforms to expectations of distribution by plow
I	$2.25^\circ$	Large sherds evenly distributed. Small sherds <i>may</i> be concentrated to southwest. However, sherd density and grid size are both small, leaving room for collection bias.	Pattern may or may not conform to normal distribution by plowing. However, alluvial washes of sand and fine gravel from the adjacent hill slopes were noted in the area. Small artifacts may be dislocated by such wash events.
H	Level	Even artifact distribution	Pattern conforms to expectations of plow distribution
J	$7.1^\circ$ over exposed bedrock, leveling off in soil and declining to $\sim 10^\circ$ through incipient gully	Artifacts strongly concentrated in peripheral areas.	Distribution does not conform to any presumed patterning process. Distribution is likely an effect of anthropogenic processes like treading crushing and dislocating sherds in the heavily trafficked area.

As the table above shows, artifact patterning observed in the surface collections largely conforms to patterns expected by the combination of slope and local formation processes. The steepest slopes show concentrations of both small and large artifacts at lower elevations, though proportionately more small sherds are concentrated than large sherds. On steep cultivated slopes like that in surface collection O, plowing likely contributes to the forced downward displacement, particularly of larger artifacts, recalling Nyssen et al.'s (2000) study of downslope displacement by tillage and its differential impact on large artifacts relative to small ones. Additionally, undercutting of the slope by the construction of the ditch for the adjacent bund has likely helped aggregate artifacts at the surface by selectively washing away the soil into the trench, exaggerating the apparent concentration of both large and small ceramics in the area. Undercutting of soils leading to the concentration of both large and small ceramic sherds also appear to be occurring in collection areas like A and L. Collections like L help illustrate the contrast

between the even distribution of artifacts by plowing seen on the main collection area, and the concentration of artifacts caused by downslope movement and erosive undercutting at the gulley head.

On the opposite end of the spectrum, level surfaces like those at H and F show the expected even distribution of sherds expected of plowing. However, other forces are also likely active in some of these settings. At collection I, for example, what appears to be a slight increase in the number of small sherds over the low elevation could be a result of high overland flow washing off the adjacent hillslope, resulting in periodic washes pushing small ceramics forward, much as they have left fine concentrations of sand and fine gravel in the area. Collection G on Tarla Terrara also poses some interpretive challenge as large artifacts are mostly concentrated near the gently sloped margins of the collection area. A number of factors may be responsible for this. For starters, considering that the field was only plowed for a short duration according *Ato* Dejene, perhaps the field does not yet exemplify the even distribution caused by regular plowing. Alternatively, combinations of human and natural forces may be creating the pattern, such as undercutting of the margins or trampling across the hill's apex, fragmenting large. Simple collection bias caused by the presence of thorny scrub may also be culpable.

The only collection area that does not approach any known pattern is surface collection J, the saddle adjacent to Kiflie Mado. Besides having one of the most unusual topographic patterns, it also has the most unusual ceramic distribution, with both large and small sherds tightly concentrated in areas with no clear respect to topography. The area was one of the most heavily trafficked in the study area, being a bottleneck of travel from the Village to other areas in the region. Quite likely such foot traffic is trampling and crushing sherds, while erosive processes are removing the small debris or concentrating in areas off the trodden paths. Oddly, however, sketches of the footpaths in the surface collection do not seem to support this, though it does not account for things like seasonal changes in footpath placement or the effects of driving livestock over the saddle.

Before concluding, it is worth noting the disparities in the volume of the recovery of lithics across surface collections. Discussed in detail in Chapter 6, lithic artifacts, primarily small flaked stones, were found in relative abundance in more recent surface

contexts like surface collections L and H, but were quite rare by comparison in other surface collections like those across Tabot Madera. From an interpretive standpoint, these disparities could be very meaningful were these undisturbed contexts. However, in plowzone contexts, the disparity is likely an effect of plowing and erosion.

As discussed above, smaller artifacts tend to submerge in the plowzone with repeated plowing. Smaller artifacts like lithics, compared to ceramic sherds, would then be expected to be less numerous at the surface over time. Likewise, lithics, with their low mass and generally broad dorsal and ventral surfaces relative to ceramics, would also be entrained by fluvial events like overland flow, sheet wash, and rilling more readily than larger ceramics. Thus those that remain on the surface rather than in the plowzone would be more susceptible to erode away than stay on the surface. Quite possibly, by favoring ceramic concentrations for the placement of surface collections, and by not sifting through plowsoil, a disproportionate amount of lithics were overlooked in collecting. More recent surface assemblages like those on Alem Doret have not been exposed to plowing or erosion for as long the surface assemblages on Tabot Madera, and so a higher proportion of lithic artifacts remain in the vicinity of their original locus of deposition and on the surface.

## **Chapter 6**

### **Artifacts**

#### **Part I: Ceramics**

##### **6.1. Introduction**

The following section provides a general overview of the ceramic assemblage from the research area. It opens with brief descriptions of the role of ceramic artifacts in the daily life of residents today, how and why some ceramic types have fallen out of favor, and why others are likely to persist through the near future. This is followed then by an ethnographic account of ceramic production by *Wayzeru* Tsehaynesh and her female relatives. Tsehaynesh's production equipment, methods, and pottery styles reproduce patterns seen in the archaeological assemblage and thus explain with a degree of assuredness how the archaeological ceramics were produced and what values lay behind their manufacture and use. Both in the field and during analysis, study of Tsehaynesh's pottery practices were invaluable for understanding and interpreting the assemblage.

The second part of the ceramics section turns to the assemblage itself, outlining previous research and the theory behind the analytical approach taken. There is little previous research on ceramics from this area and period; broader comparison shows a number of historical and regional patterns that have continued from Aksum through the present, while highlighting some possible differences that may be important to future chronological seriation. It is worthwhile to explain the theory behind the analytical



approach here because the approach is so different from previous analyses done in Ethiopia. While previous research has relied on typologies based on a few characteristics, the approach here starts with multivariate recording and proceeds to seek potentially meaningful relationships and patterns between variables. The result, I hope, will facilitate comparison of this assemblage with future collections and lead toward a more productive understanding of regional ceramics as a corpus is built up from what are likely to be sites as poorly preserved as Gännäta Maryam.

This section then leads into a description of the assemblage itself, describing features and patterns among variables like temper, surface treatments, decoration, and vessel forms. It concludes with a discussion of patterns in the assemblage, particularly spatial and temporal features, few as they are in the heavily disturbed contexts from which most were recovered. Nevertheless, there are a few features which may have temporal relevance, and some clear patterns in spatial distribution.

The purpose of the ceramics section of this chapter is to provide a general description and essential information on the ceramic assemblage at Gännäta Maryam including key features, notable patterns, and issues germane to the wider research project such as chronological features. Appendix E supplements this ceramics section with a more exhaustive account of the ceramic analysis and assemblage intended to facilitate future comparisons of this assemblage with others from the region. The appendix provides information such as criteria and definitions used in the analysis and a more detailed examination and discussion of sub-types of different rim and body forms.

## **6.2. Contemporary ceramic use and ceramic alternatives in Gännäta Maryam**

Modern and traditional ceramic production practices at Gännäta Maryam as reported by the potter Tsehaynesh and her family, were useful for interpreting many of the archaeological finds, though distinct differences exist between contemporary practices, customary practices as reported, and the archaeological assemblage. Aside from the observation of the majority of pottery recovered from the recently abandoned

*tukul* at Alem Doret, Tsehaynesh confirms that the archaeological pottery bears some differences in form, composition, and decoration from current products.

According to Tsehaynesh, potters today play a far less significant role in the communities of her region than they did in generations passed. Modern goods made of plastics and enameled metal have largely replaced many vessel types traditionally made of clay. Plastic jerry cans used for carrying and storing water, for example, are far lighter and more durable than their ceramic counterparts. Similarly, plastic bowls and buckets with fitted lids are more durable and can store foodstuffs and guard against insect invasion far more effectively than traditional ceramic materials. Enameled or plastic platters, cups, pitchers, and bowls offer a colorful and easily cleaned alternative to their traditional earthenware counterparts. In areas with greater economic power and modern amenities, aluminum pots and pans also compete with traditional alternatives. Meanwhile, the economic sensibility of repurposing tin cans and plastic bottles after the consumption of their original contents is clear to many families. However, while these modern goods may be desirable alternatives to traditional materials, they are not necessarily cheaper than ceramics, and many families possess a mix of both ceramic and industrial goods.

In certain contexts, ceramic vessels are preferred and have few if any socially acceptable alternatives. Even in urban areas, many Ethiopians continue to cook the traditional flat bread *njera* on ceramic griddles known as a *mogogo* or *mitad*. While metal alternatives are available, they are more frequently used for toasting or frying other food items like grain and meat. The *jebena*, the iconic Ethiopian coffee pot also has no mass-produced equivalent of a similar form, and one suspects that using an alternative like a metal kettle would be considered a violation of Ethiopian custom, hospitality, and aesthetics. When asked what kind of pots Tsehaynesh and her family make and sell most frequently, it was these latter two that she referenced, in addition to ceramic beer-brewing pots, cooking pots, and very wide basins for storing prepared *njera*. While metal cooking pots are certainly available, some residents claimed they preferred ceramic pots, or that ceramic pots were more affordable. Finally, Tsehaynesh believes that her family probably uses more and a wider variety of ceramic goods than their neighbors because they take pride in the tradition and skills of their craft and their self-sufficiency. The

following figures (Figures 6.1-4) illustrate some modern ceramic vessels produced in the Gännäta Maryam / Lalibela region.



Figure 6.1. Modern pots made by Tsehaynesh at Gännäta Maryam. Top left is a red-slipped and burnished *jebena*, or coffee pot; top middle and right are cooking pots with slipped and burnished lids and rims. Bottom middle and right are water or beer pots decorated with punctates and incising.





Figure 6.2. Beer pot made by Tsehaynesh at Gännäta Maryam, red-slipped and burnished above the shoulder, trimmed by scraping and cutting below the shoulder.



Figure 6.3. Examples of modern regional pottery held by the Lalibela Cultural Center. Note the individual cylindrical ceramic feet supporting the cooking pot, top left, and the knobs supporting the *jebena* in the firebox, bottom center. The large basin in the bottom left is most commonly used for short-term storage of prepared *njera*, though I observed similar vessels made of daub like the lid to the right of the platter.





Figure 6.4. *Mogogo/mitad* or similar cooking griddle supported by three independent ceramic "feet." The lidded jar next to the coals has a lid similar to those found in the Gännäta Maryam assemblage.

### 6.3. Contemporary ceramic production and similarities with the archaeological assemblage

Ceramics are produced first by acquiring and preparing the clay. Tsehaynesh claimed under Ethiopia's feudal system, blacksmiths and potters were vassal subjects of the local authority, usually lords, large landholders, or the clergy. These people possessed *gult* rights, which gave them limited control over the labor and resources of the land, and the subjects to work it (Crummey 2000: 8-12). Under this system, potters were granted permission to acquire clay from local sources regardless of whether the land was simultaneously claimed by peasant farmers. According to Tsehaynesh the best clay in the area came from the dense Vertisol clays of Tabot Madera. The land reforms of the Derg government, however, abolished the *gult* system and local committees were tasked with dividing the land for exclusive use by single families. This virtually ended potters' free reign to gather resources where they wished. Tsehaynesh feared that attempting to acquire clay from Tabot Madera would result in harassment from the landowner, and a demand for money in exchange for the clay. The latter would likely rendering her craft

economically unsustainable. After the reforms, then, many potters were forced to make do with the soil found on the property allotted to them, whether or not it normally would have been considered suitable for the purpose. The soil from Tsehaynesh's family property, for example, had a far lower clay content than the preferred Vertisol, so much so that she bemoaned the coarse, brittle pottery it produced, even after aging and tempering.

If needed, the clay (and tempering agents) is pulverized with a mortar and pestle, or more commonly a spent grinding stone (Figure 6.5). Two tempers are then added to the clay: a mineral referred to as *geha*, and sand from the wadi. Tsehaynesh said grog could be used as an alternative, though was not normally preferred, at least by her family.



Figure 6.5. Grinding stone used for refining clay and temper by Tsehaynesh at Gännäta Maryam. This grinding stone was previously used for food preparation. When such stones begin to develop a significant groove, they are no longer desired for food preparation, but are appreciated by potters for refining raw materials.

The mineral *geha* is tentatively identified as trachyte. The *geha* is found as cobbles to very large stones in many areas of the region. Tsehaynesh gathers hers from

the valley below Gännäta Maryam near the Takezze River. Elsewhere in the region, *geha* is commonly encountered in river beds and used as building stone. The rock is aphanitic to porphyritic, with varying inclusions of hard, transparent crystals, the largest and most common possibly being quartz or a feldspathoid mineral such as sanadine. Generally, the aphanitic *geha* has small to nearly invisible phenocrysts, while the phenocrysts are much larger in the porphyritic varieties. Color varies among pale grays, greens, yellows, and reds. While studying samples of Ethiopian ceramics from the Aksumite and pre-Aksumite periods from Yeha and Matara, Gautier (1976: 65) also identified trachyte as the dominant temper in the Yeha assemblage.

When I first began the ceramic analysis, I initially thought the different colors of stone temper may represent different minerals, but learned after discussions with the potters that they are all the same mineral and that color is considered inconsequential. Rather than color, Tsehaynesh's family explained that they recognized three grades of *geha* based on grain size. Aphanitic *geha* with the smoothest texture, smallest phenocrysts, and least volume of hard crystalline inclusions can be easily pulverized and makes the best temper. Slightly coarser *geha* with greater crystalline inclusions, however, is far more common, and out of convenience is used just as readily as its finer counterpart. The porphyritic *geha*, which often has more and larger phenocrysts, including the hard crystalline inclusions, is not deemed appropriate for ceramic temper, though Tsehaynesh claims it is frequently used for grinding stones. After collection, the *geha* is broken into smaller pieces and ground to consistencies ranging from a coarse grit (observed in archaeological ceramics) to a flour-like powder (observed in Tsehaynesh's practice). In the archaeological samples, the *geha* temper was usually two millimeters or less in diameter. The clear crystalline inclusions, being harder than the matrix materials, must not pulverize as well, as they were a common inclusion of ceramics tempered with *geha*. In some instances, only these crystals were observable, and it is likely the *geha* was pulverized too finely to be seen without greater magnification, or its color was too similar to the fired paste to be distinguishable from it.

The other temper Tsehaynesh and her family traditionally employ and also commonly observed in the archaeological ceramics is sand. The local potters gather theirs from the wadi in the center of the terrace, though sand with a similar gross



appearance is found in dry fluvial channels throughout the area and Tsehaynesh says it is equally as usable. cursory inspection of the sand suggests it is composed largely of mafic and other minerals from the predominantly volcanic strata of the mountains. Coarse grains of amphibole are the most common; less common were calcite crystals, found in some rocks in the area, small ferrous nodules, and larger grains of other bedrock types such as the red stone from which the church is carved. The sand is generally fairly poorly sorted, ranging from half a millimeter or less up to one to two millimeters. During fieldwork the wadi had been dry for some time and its bed heavily disturbed by human and animal traffic. Potentially fluvial processes could sort the sand along a pristine bed and potters through time may have preferred a certain grain sizes, though Tsehaynesh did not express one.

When tempering the pottery, Tsehaynesh claims that the proportion of sand and *geha* she uses depends on the intended use of the ceramics. The *geha*, she claims, is the most important temper, improving the strength and durability of the vessel. *Geha*, being less dense than the clay paste, also reduces the overall weight of the vessel, thus making it suitable for things like water jugs. By contrast, sand, she claims, is used primarily for vessels which will undergo heating, such as *mogogos* and cooking pots. The sand is believed to help absorb and radiate heat, improving the cooking and reducing the amount of fuel required. Sand, however, also adds significant weight to the vessels and is not believed to improve the durability of the vessel as well as *geha*. Tsehaynesh said she often uses both tempers in any given clay mixture, citing the importance of *geha* in particular, though she will vary the ratio to suite the intentions of the final product.

Construction of the vessels can follow a number of courses. Small vessels are pinched from a block of clay. Larger vessels are coil built and rubbed smooth. Flat vessels like *mogogos* may primarily be pounded out of a block of clay. In many instances, larger vessels are constructed in two or more parts; the base may be shaped from a block of clay, while the body is built up from coils. The ceramic is then lifted and the excess clay beneath and around the base is cut away with a knife. This cutting creates a very characteristic feature of the contemporary and archaeological pottery at Gännäta Maryam. The movement of the blade over the clay cuts the paste smoothly, but catches grains of temper and drags them across the surface, leaving distinct rasping marks

terminating in the temper grains. The knife also frequently produces flat facets which, on a round body, results in a series of noticeable surfaces distinguished by a slight change in angle. Though this technique was very common in the archaeological assemblage at Gännäta Maryam, I could not find accounts of this practice or its characteristic features elsewhere in publications of Ethiopian ceramic assemblages.

After formation, the pots can be subject to a number of final treatments. Tsehaynesh may wet a piece of cloth or leather and rub it across the freshly made ceramic surface, creating an appearance similar to, though not as fine as, a burnished ceramic. When burnishing is preferred, the ceramic is dried to the leather hard state and rubbed smooth with a river pebble. A red slip is made from another local mineral source and may also be applied to the surface. Tsehaynesh admits that while she could burnish slipped vessels to a high gloss, time requirements and apathetic consumers means her family frequently only burnishes certain vessels like *mogogos* to a high glossy finish, leaving others with a duller, uneven burnish. Other decorative treatments are fairly limited to stippling or incising the leather-hard clay with a small stick, or impressing her fingernail around the vessel. These may occasionally coincide with the appliqué of thin coils of clay to the vessel surface like the pot featured in Figure 6.2.

The final stage of ceramic preparation is the firing process. Ceramics are usually produced in either black, or oxidized colors. In both cases a shallow pit is dug and roughly walled with large fragments of broken pottery and/or fragments of basalt (Figure 6.6). To produce oxidized pottery, pots are surrounded by wood and let to burn with exposure to the air. This sometimes produces reduced or partially reduced spots on the otherwise oxidized vessel. To produce black pottery, a reducing atmosphere is created by encasing the pots in damp cow dung prior to firing, a practice that has been reported elsewhere in northern Ethiopia (Messing 1957). The vessels are then placed in the pit and more densely covered by wood and sometimes earth.



Figure 6.6. Ceramics firing pit recently used by Tsehaynesh at Gännäta Maryam. The pit was lined with old ceramics and vesicular basalt. Some ceramic fragments in the middle were reportedly from a vessel that broke during firing.

For some vessels, cooking vessels in particular, a final treatment is done prior to use. Ceramics like cooking pots and *mogogos* are washed in milk and/or rubbed with pulverized niger seed (*Guizotia abyssinica*) or similarly oily substances. The vessels are then heated as though they were being used to cook something, completing the impregnation. Griddles like the *mogogo* are also frequently oiled in the course of regular use. Such practices have also been recorded elsewhere in Ethiopia (Messing 1957).

#### 6.4. The archaeological assemblage: Introduction

Ceramic artifacts were by far the most common artifact type encountered while working in the region. Over 700 sherds, not including those deemed too small for full multivariate recording, were recovered over every context studied. As one of the few modern excavations conducted at either a post-Aksumite site or a site in the historic Lasta region, I considered a detailed analysis of the material and the creation of a ceramic

typology a paramount objective of the project. While some valuable insight was gleaned from this study, a number of factors hampered a more thorough analysis and description of the local pottery tradition and history. Because of the paucity of intact archaeological contexts and limited excavations, only a small proportion of material has come from stratified archaeological contexts. The majority of material came from surface collections where exposure to plowing and weathering has left them fragmented, eroded, and most likely conflated with material from different periods and contexts.

Because of poor preservation and disturbed recovery contexts, it is difficult to develop a typology that clearly reflects the forms and functions of complete vessels. Vessel rims, for example, often lacked sufficient continuity to the body of the vessel to interpret the original vessel form. In many instances discrepancies in rim diameter and composition suggest that similarly shaped and angled rims probably represent more than one vessel type. This complicates the discovery of patterns related to other attributes such as paste, temper, decoration, or firing that might reveal further information about the use and function of ceramic types. In the absence of stratified contexts, it is impossible to determine how, until very recently, vessel forms and compositions compare over time.

In spite of these problems, I argue I have made some important observations regarding the ceramic forms and compositions which will provide a foundation for future study in this region. While the collection shows some similarities to other collections from northern Ethiopia, important differences, such as the absence of Christian motifs and Ge'ez characters, found elsewhere (e.g. Wilding and Munro-Hay, 1989: 297; Phillips 2000: 327; Poissonnier et al. 2012: 142; Tesfaye unpublished; Mengistu unpublished) are notable and perhaps of temporal or cultural significance. There are also some diagnostic differences between ceramics produced prior to the 1970s land reforms, and those produced afterward. Spatial distribution patterns are also evident, though the absence of *in situ* contexts hampers interpreting the significance of these patterns.

## 6.5. Previous research and caveats

Following the conclusion of this thesis that natural and anthropogenic formation processes progressively degrade archaeological contexts and artifacts, it is presumed that much of the ceramic material recovered dates to the past few centuries. This assumption is supported by the radiocarbon dating of some archaeological contexts (Chapter 4) and oral histories which place many contexts between the 17th to late 20th centuries. While some ceramics, from the surface collections in particular, may be much older, without better contexts there is little evidence on which to identify or date such sherds. This poses two challenges to the comparison of the recovered ceramics with previous research. Firstly, the majority of well developed ceramic analyses and typologies in northern Ethiopia come primarily from Tigray at elite sites like Aksum (e.g. Wilding and Munro-Hay 1989; Phillipson et al. 2000). The historically ethnic Agaw heartland encompassing Gännäta Maryam meanwhile has a long tradition of historical, cultural and ethnic distinction from the rest of the Ethiopian state, verging on autonomy during many periods, (see discussions by Abir 1980: 181, Haile 1988, and Derat 2009). This does not necessarily mean that the ceramic tradition of the region was likewise as independent, but it cautions against uncritical comparison to other assemblages.

Secondly, much of the emphasis of research at these regions and sites has been on first millennium and earlier contexts associated with the Aksumite and pre-Aksumite periods, with less attention given to later materials and sites (e.g. Wilding 1989: 235-236; Michels 2005; see also Clapham 2002, and Phillipson 2004, for a discussion of the spatial, temporal and topical research biases in Ethiopian studies in the disciplines of history and archaeology). While there has been some research on ceramics from regions and periods possibly more germane to the collections from Gännäta Maryam (e.g. Dombrowski 1970, 1972; Joussaume 1985, 1995; Taffere 2010; Tesfaye unpublished; Chuniaud 2012), some of these published assemblages lack the quantity and thoroughness that has emerged from the long and intense scrutiny of the Aksumite region and period. Furthermore, many of these assemblages come from particular contexts unlikely to contain the same types and relative frequencies of ceramic material as found at Gännäta Maryam. For example, much of the well-documented Aksumite period

material has come from exceptional contexts like elite and ritual sites and burials. Tesfaye's (2011) assemblage, similarly, came from a multi-chambered tumulus burial, unknown around the Gännäta Maryam/Lalibela region, and also includes material presented to the researcher by local residents from undocumented contexts. Taffere's (2010) collection, meanwhile, comes from two sources: a looted cemetery of unknown date in Lalibela, and the baptismal pool of Beta Maryam church. Dombrowski's (1970, 1972) material comes from two cave sites of Post-Aksumite date. It is possible that the assemblages from these unusual contexts represent a narrow segment of the contemporary repertoire selected for the particular and unusual contexts from which they were recovered. On the other hand, the ceramics at Gännäta Maryam likely represent, at a minimum, a broad cross-section of mundane wares used by peasant agriculturalists discarded or lost in the course of their use-life.

The location and historical context is also worth noting for other collections, even though there are strong similarities among the ceramics. Joussaume's (1985) work at Tiya probably represents a distinct culture from the Agaw, Amhara, and Tigray populations of the other collections, notable for their fields of early second millennium stelae. The tumuli burials from Tesfaye's collection are of similar date, and not far from Gännäta Maryam, though their location suggests they originated with the Amharic ethnic group, rather than the Agaw, who do not appear to have constructed tumuli in their region. Chuniaud's (2012) assemblage from Meshala Maryam, Manz administrative district, also likely belongs to the Amharic ethnic group. Much of their material is contemporary to Tesfaye's material, though it was recovered from a variety of contexts, including the vicinity of a historic church, tumuli burials, and a number of structural remains that oral history associates with the royal camp of king Ba'eda Maryam (r. ~1468-1478). This latter association, however, could not be proven (Derat 2010, Derat and Jouquand 2012). Regardless, the Meshala Maryam material provides the largest and visually most similar collection of ceramic artifacts to those recovered at Gännäta Maryam.

In order to better understand local ceramic production and the archaeological material, I asked Tsehaynesh to prepare a number of "control" sherds. I provided her with a bag of clay from a shovel test where she claims she would collect clay today if she

were able (Tabot Madera, Area A). She was then asked to make a series of clay patties, each with a different temper (sand, *geha*, grog) and combinations of those tempers. One sample had no temper. The untempered sample crazed during drying and fell apart shortly after firing. The rest of the patties were intentionally broken in half and examined for comparison with the archaeological assemblage.

## 6.6. Analytical approach

As mentioned above, the majority of ceramics from Gännäta Maryam were heavily worn and broken, and lacked stratigraphic context. What is known of the ceramic tradition in the region is primarily isolated to modern practices explained by Tsehaynesh's family and observed in contemporary residents' use of ceramic objects. In the absence of a regionally established model for classification, then, the analysis began with a consideration of all recordable attributes, rather than the *a priori* selection of a limited number of characteristics. From here, patterns were sought in the data, though ultimately some highly distinctive attributes like rim type and diameter were used as the basis for a preliminary classification scheme.

The analysis of the Gännäta Maryam assemblage is based on the multivariate approach encouraged by theorists such as Redman (1978) and put into practice by McIntosh (1995). Additionally, I understood the utility comparative collections of a similar time frame and regional context could provide. Since no such collection has been described, I therefore considered it important to begin one. Thus Sinopoli's (1991: 43-44) call to report numerous variables even though they may seem intuitively irrelevant to a typology for my own ends (Clarke's essential and inessential variables, 1968: 71) was headed. Sinopoli (1991), and McIntosh (1995: 130) in particular, argue that such a multivariate recording approach provides the flexibility needed to continue asking questions of the collection in the future. This feels particularly important since the contexts and conditions of the assemblage here is so poor, limiting the utility and possibly accuracy of any typology to address particular questions or reflect meaningful archaeological patterns, particularly as they regard chronological questions. The

recovery of regionally and chronologically related assemblages in the future will undoubtedly abet the production of a much more nuanced analysis and typologies for the region, and so it is important to keep in mind this future potential and needs.

This forward-thinking approach is also taken in response to perceived shortcomings in ceramic analysis elsewhere in Ethiopia. At Aksum, for example, the classification scheme devised by Wilding and Munro-Hay (in Munro-Hay 1989) has been adopted by Phillipson (2000) and has been expanded to other settings (e.g. D'Andrea's pre-Aksumite Mezber excavations, pers. comm.). This classification of indigenously produced pottery is based on only two factors: vessel color (red, black, and brown), which is not defined objectively by Wilding and Munro-Hay (1989), and secondarily vessel form (profile, decoration, and diameter). The exclusive use of these limited criteria makes further analysis impossible without returning to the original collections. This type-variety approach also potentially falls into the trap described by Redman (1978: 160): fragmentary sherds may present only a limited number of attributes for the wider type, while the artifacts and types may not then represent the total extent of variability and alternate attributes an assemblage may contain. It seems quite possible from the Aksumite assemblage that in defining types by such narrow criteria, a wide range of potentially meaningful variables or variations have been pared away, while artifacts have been lumped into categories that fit *a priori* expectations rather than reflecting real differences.

Analysis then unfolded along the scheme described and employed by McIntosh (1995: 131). Artifacts were first individually examined and the characteristics of numerous features were recorded using standardized definitions, whether or not they felt intuitively valuable in the beginning. Patterns were then sought out within the data, such as the co-occurrence or spatial distribution of attributes, and the comparison of attributes with the ethnographic data on ceramic manufacture. Where very distinctive features like rim profiles were available, a preliminary classification was made based on this feature in addition to features such as diameter, and further patterns were sought out among these classes. Due to the lack of chronological control in many collection areas and the fragmentary nature of the assemblage, the classifications and analysis are not perfect, though they provide the groundwork for future analyses of hopefully better



contextualized remains from the region, followed by the possibility of a retrospective reclassification of this assemblage.

Following fieldwork, a sample of 18 sherds from different proveniences, with different pastes, tempers, and possible vessel types were submitted to University College of London's ceramic petrography lab. There, Dr. Patrick Quinn produced and analyzed thin sections of the sherds (Quinn 2012). His report is included in Appendix F. Quinn's sample is too small to draw broad conclusions about the remainder of the assemblage with which this chapter is concerned, though in many instances it provides some insight into possible macroscopic features discovered and supports the conclusion that the majority of ceramics were likely produced around Gännäta Maryam, or at least in the region around Mount Abuna Yosef.

## **6.7. Recovery, sampling, and analysis procedures**

Recovery of ceramic materials has already been covered in detail in Chapter 4. It is sufficient to recap here by reiterating in the lab, generally anything less than roughly a centimeter in diameter was discarded. Of those remaining ceramics, anything less than about 1.5 to two centimeters was considered too small for accurate description of attributes like type and percentage of tempers. These "small" sherds were set aside and collectively counted and weighed for each collection context. "Large" sherds, anything larger than about 1.5 cm, were subject to full multivariate recording (Figure 6.7). The one exception to these size-based conditions were uniquely identifiable ceramics, like fragments of rim sherds and, primarily, "Fine Red Ware" ceramics described below. Though these ceramics were recorded individually in order to note the existence of their distinguishing attribute (e.g. rim, decorative treatments, "Fine Red Wares"), other attributes of the pieces were only recorded if they could be accurately observed or measured.

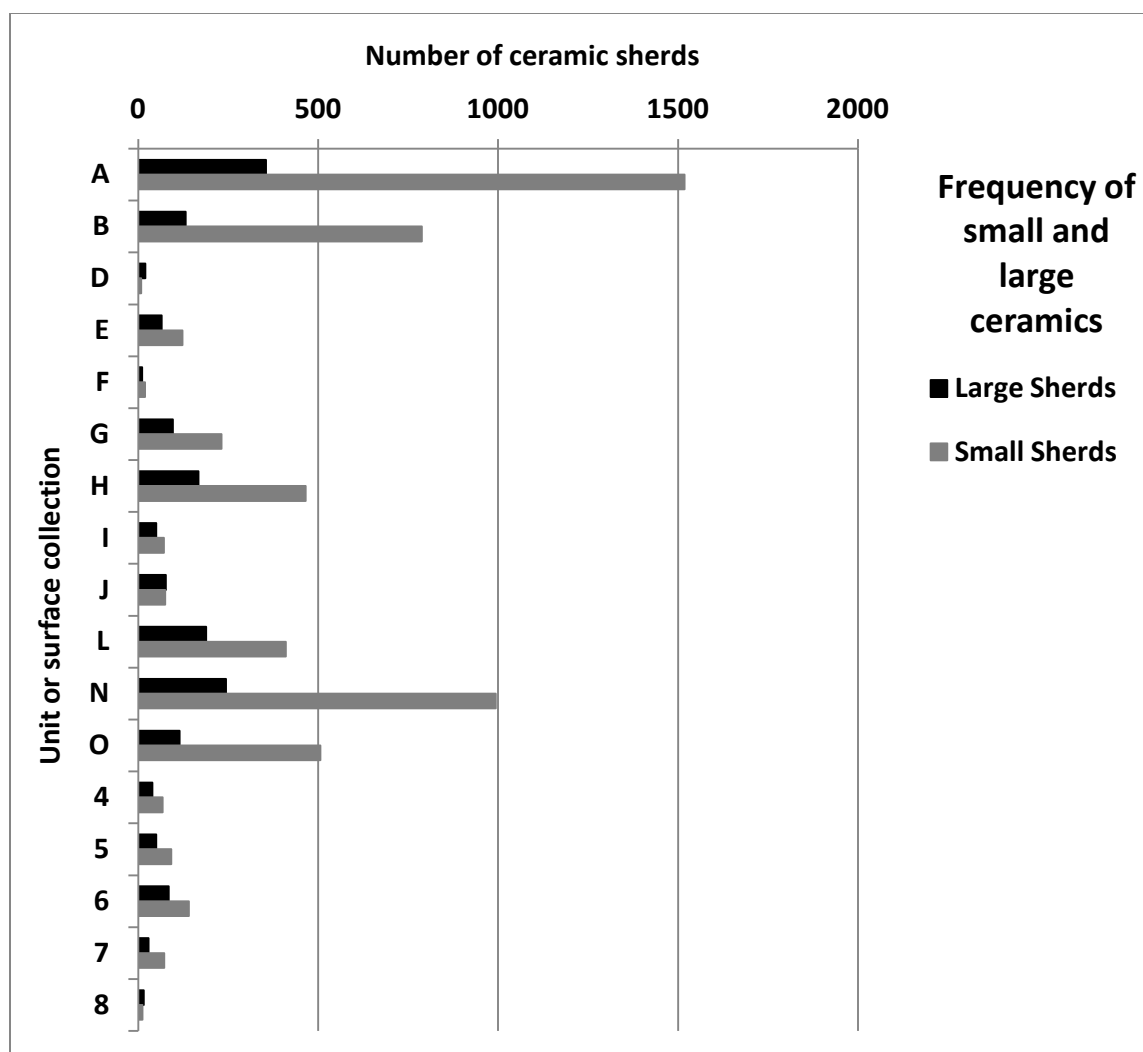


Figure 6.7. Frequency of "small" and "large" category ceramics by recovery context.

Due to time constraints, a complete analysis of every ceramic was not feasible. All materials recovered from excavations were analyzed, as were ceramics from special contexts like the abandoned *tukul* at Alem Doret and the former location of the blacksmith/potter family at Kiflie Mado. Surface collections with only a small number of ceramics were also analyzed entirely. Only in surface collections A, B, E, G and N, which were proportionately larger in scale or possessed greater artifact density than other collections were some materials separated and not fully analyzed. Collection bags from these collections were pooled by collection letter and pulled at random. Thirty-three percent of collection units was decided as the minimum required for full multivariate recording though time allowed for more units to be analyzed in all cases (the breakdown

of percentage analyzed: A=59%, B=35%, E=42%, G=66%, N=40%). The remainder of the ceramics were sorted by temper and paste and recorded collectively by those attributes. Exception was made for rim sherds, decorated sherds, or anything else with potentially diagnostic features (i.e. were not undecorated body sherds); such ceramics were fully documented.

All ceramics were observed under a 30x magnification jeweler's loupe and/or microscope. A freshly broken edge was used to determine information about temper and firing. In nearly all cases of decorated and rim sherds and similarly identifiable body sherds (e.g. handles, feet) the artifacts were drawn and the drawings digitized. Photographs were taken of ceramics representative of different decorative techniques, manufacturing techniques and other attributes, as were a few particularly noteworthy sherds. Following initial recording on paper, data was entered into Microsoft Access for digital storage and analysis.

## 6.8. Ceramic ware types

The ceramic assemblage is divided into three distinct ceramic types. The most frequent types were what I have termed "historic wares" and "contemporary wares." Historic wares comprise all ceramics from excavations and the majority of sherds from surface collections except surface collection L. Surface collection L, the *tukul* site on Alem Doret, and to a lesser extent collection H nearby, are the source of the majority of contemporary wares. The differences between the two are based on paste qualities and composition and appear to reflect the time period and conditions of production. Details of these differences are provided during the relevant topical discussions below. In general, however, historic wares are characterized by their dense, hard paste and lower volume of temper. Contemporary wares, meanwhile, are much more friable, break with a coarser, blockier edge, and contain on average more temper than historic wares. However, there appears to be few differences in vessel forms.

The names given to these wares are intended to imply their presumed origins: Historic wares, with their fine, dense fabric are believed to represent the local ideal

ceramic composition using vertic clay like that from the Vertisol fields Tsehaynesh reports she would ideally quarry. Contemporary wares are the ceramics produced by Tsehaynesh, and very likely many others today, now that access to these Vertisol areas is restricted and potters are making do with inferior quality clays. Indeed, Tsehaynesh's ceramic fabrics, along with decoration, are identical macroscopically to the contemporary wares from Alem Doret and rarely recovered elsewhere in the study area. The temporal division is not an absolute one, however, as it is possible some potters in the region have retained access to traditional clay sources and continue to produce ceramics with a fabric like the historic wares.

The third ceramic ware I have termed "Fine Red Wares." These ceramics are characterized by their exceptionally thin walls and intense red, red-orange, or pink paste colors. Of 63 sherds recovered across the study area, the average thickness is 5.2 mm with a standard deviation of 1.75 mm. *Munsell Soil-Color Chart* (2010) chips do not match the color range of these sherds precisely, though 5R 5/-6, 7.5R 6/8, and 10R 6/-7/8 are the closest matches. Frequently the core of the ceramic profile was reduced to a light gray and many were noted for their unusually fine, dense paste. Other features like temper are similar to the historic wares. All these sherds were very small and aggraded, making further detailed analysis difficult. Five examples have possible traces of red or brown slip on them, though were so eroded this could not be confirmed with certainty.

Unlike many rim and vessel forms, Fine Red Wares were strongly localized in certain areas. All Fine Red Wares were found on the lower terrace of the study area. The majority of sherds and highest densities were concentrated in surface collections D, E, and F in the northeast area of Alem Doret, Area A. Elsewhere, they were recovered only very rarely and made up only a very small percentage of the total assemblages (Table 6.1).

Table 6.1. Distribution of Fine Red Wares by count and percentage of assemblage per surface collection or excavation area (n = 63).

Collection Location:	A	B	D	E	F	G	H	I	L	N	Unit 4	Unit 5
n =	7	2	3	22	3	5	2	1	8	3	3	3
% of Fine Red Ware	11.3	3.23	4.84	35.48	4.84	8.06	3.23	1.61	12.9	4.84	4.84	4.84
% of total analyzed sherds	1.97	1.52	15.0	33.85	27.27	5.21	1.20	2.00	4.23	1.23	7.69	5.45
% by total collected sherds	0.37	0.22	10.71	11.70	10.0	1.53	0.32	0.83	1.34	0.24	2.88	2.04

## 6.9. Manufacturing and paste

The ceramic assemblage from Gännäta Maryam is composed of indigenously produced, low-fired earthenwares (< 850-750° C according to Quinn, 2013) shaped by a combination of coiling, hand-building, and cutting techniques consistent with contemporary practices described by Tsehaynesh. Paste color was most frequently brown, though occasionally red or orange-red. Oxidation during firing appears to have controlled the intensity of the color. Many ceramics were also reduced to black. With the exception of Fine Red Wares, discussed below, there appears to be no correlation between paste color and other variables. Most likely, red, brown or shades in between were the inevitable outcome of clay sources and firing and of little concern to consumers. Nearly all rim and vessel styles were produced in both reduced and oxidized forms.

With fewer than half a dozen exceptions, all sherds contained non-plastic inclusions (NPI) visible to the naked eye or under low magnification. *Geha* and sand were by far the most common NPI/temper classes, used together in nearly two thirds to three quarters of the time per recovery context (Figure 6.8). In temporally well defined contexts like excavation units 4 and 5 on Tarla Terrara (also collection G there), and unit 6 on Kiflie Mado, *geha* temper alone accounts for nearly 40% or more of ceramic NPIs. Most surface collections have more equitable frequency distributions, though there is the possibility these contexts contain ceramics representing wider temporal expanses and origins. Grog was the only other definite temper, found in 16 sherds mostly from Kiflie Mado, though Quinn (2013) identified grog in some examples not noticed during macroscopic analysis leaving open the possibility that the count is an underestimate.

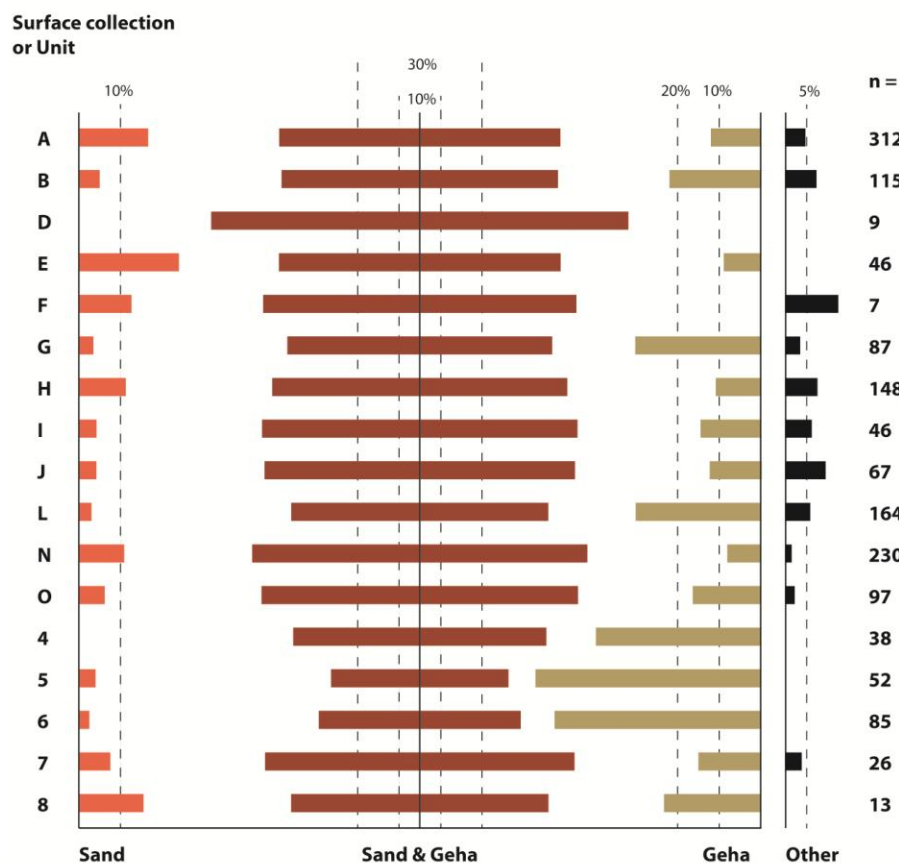


Figure 6.8. Relative frequencies of tempering with sand, *geha*, or both by recovery area.

Mica and voids were also encountered, though it is unknown if they were intentionally added or were an incidental feature of the clay source and processing. Likewise, minute inclusions gave some ceramics a sparkly appearance. The crystals were too small for identification and quantification at 30x magnification; the effect was noted, but not recorded as an official temper. Quinn (2013) notes the presence of volcanic glass in some ceramic sherds, and these may be the cause, though he does not speculate as to whether they were part of the clay source or intentional inclusions. Large, clear crystals, often between 1-2 mm long were also frequently encountered and initially recorded as their own temper class. However, through observation of Tsehaynesh's work and sampling of her tempers, I determined that these crystals are a constituent of the *geha* mineral and thus a result of *geha* tempering.

While the frequency of the use of *geha* and sand tempers were fairly consistent across assemblages, one point of difference among some ceramic types and collections

was the volume of temper used. Volume of temper was recorded by approximate percentage of area occupied by the temper along a freshly broken edge. Most sherds had between three and five percent of either temper or both. Two exceptions, however, stand out.

The first exception is between historic and contemporary wares. Historic wares, being the majority of ceramics, establish the average temper volume of three to five percent of one or both tempers. Contemporary wares, by contrast, regularly have 10% or more of *geha*, sand, or both, though often with a preference for more *geha* than sand (Figure 6.9). Among the collection L sherds, there is also a notable pattern of larger particle sizes for *geha* temper. Where the typical size among historic wares is frequently about one millimeter, *geha* in contemporary wares are frequently as large as two millimeters. By volume, the same percentage of *geha* was noted in the test samples and misfired pottery produced by Tsehaynesh and her family, though the grain size is more consistent with the historic wares.





















	SC-A					SC-L				
		<i>geha</i>		<i>sand</i>			<i>geha</i>		<i>sand</i>	
<3	28.5%	14%			14%	<3	10.5%	6.4%		4.1%
3	30.9%	14%			17%	3	27.1%	14.2%		12.9%
3-5	1.5%	1%			0%	3-5	0.7%	0.7%		0.0%
5	22.8%	10%			13%	5	26.8%	13.2%		13.6%
5-10	3.3%	1%			2%	5-10	5.4%	3.4%		2.0%
10	10.3%	3%			7%	10	23.7%	16.6%		7.1%
10-20	2.0%	0%			2%	10-20	5.4%	3.7%		1.7%
20	0.4%	0%			0%	20	0.3%	0.3%		0.0%
>20	0.2%	0%			0%	>20	0.0%	0.0%		0.0%
	n = 456						n = 295			

Figure 6.9. Comparative charts showing the relative frequencies of temper volumes in assemblages from surface collection A and surface collection L. Collection A, comprised mostly of historic wares, is near the average for the other surface collections primarily containing historic wares around Tabot Madera. Collection L, being primarily contemporary wares, demonstrates a higher volume of *geha* tempering compared to historic wares.

The second exception divides ceramics by vessel type or function and diameter. All sherds identified as probable mogogos and all sherds with evidence for charring had between five and 10 percent of sand, *geha*, or both. Likewise, among rims with

diameters greater than or equal to 20-30 cm, one or more temper classes were present at five percent or more of the body composition. Most likely, the volume of temper is a response to the intended vessel size and function. Larger vessels and vessels that would undergo repeated heating experience more physical and/or mechanical stress during use than smaller vessels used for lighter tasks like dry storage. Additional temper may help reduce the effects of these stresses by preventing cracks and spalls from expanding to the point of destroying the vessel.

#### **6.10. Vessel components and features**

Foot rings, knobbed feet or fire box supports (see Figure 6.3), and simple coil handles were the most commonly encountered functional plastic additions to vessels. All were generally made with coiled or balled clay luted to the ceramic surface. None, however, were particularly common relative to the total number of ceramic sherds and though they appear distributed in all contexts, quantities are insufficient to identify any significant concentration. In total, there were only 29 handle fragments made from simple clay coils, six knobbed feet/supports made of balled clay, and two foot rings made from coiled clay.

The handle construction is noteworthy in some examples for its greater complexity. Only a few handles were still in contact with body sherds and many were simply smeared onto the vessel surface. In at least two examples, however, the potters had pared away clay from the ends of the handles to create a tenon joint (Figure 6.10). The tenon was then inserted into a hole cut into the ceramic vessel and both sides were smeared flush against the ceramic body. One of these handles is a historic ware, the other a contemporary ware. The technique has parallels in Aksumite ceramics (see Wilding and Munro-Hay 1989: 237).

Though many handles were fragments, two show vertical orientation, one connecting what was likely a vessel shoulder to a neck. An additional four were likely vertically oriented. Unlike most vessel bodies, handles were all undecorated except for one poorly slipped and burnished contemporary ware.





Figure 6.10. Interior of body sherds showing mortise-and-tenon style attachment of handles to bodies. The left sherd is a historic ware (Locus 8004), the right is a contemporary ware (SC L-NE (2,6)).

Another common plastic feature was a characteristic profile produced by the combination of a hand-formed base with excess clay cut away supporting walls made of coiled clay. Two profiles accounting for 26 sherds were commonly found with this technique in all contexts but surface collection L. Slightly more than half had some form of surface treatment on the exteriors above the joint and/or on the interior (see Appendix E). The first profile, pictured below (Figure 6.11), has a prominent shoulder or ledge where the two segments meet. While the upper portion is often burnished and has a rounded surface, the lower portion has a flatter face and characteristic rasping marks where the cutting object has dragged non-plastic inclusions like sand and *geha* through the wet clay. Though no examples were extant with their rim, the sherds likely represent carinated cooking pots and food service vessels seen elsewhere in the archaeological record, and often still available in markets today (Figures 6.12-13). The comparable style in the Gännäta Maryam/Lalibela region today, however, has a much smoother, rounder profile (e.g. Figure 6.1, top: middle and left pots) and may explain why this profile was

not found among contemporary wares from surface collection L. The contemporary style, however, was identified at Kiflie Mado (see the paragraph on vertical rims, below).

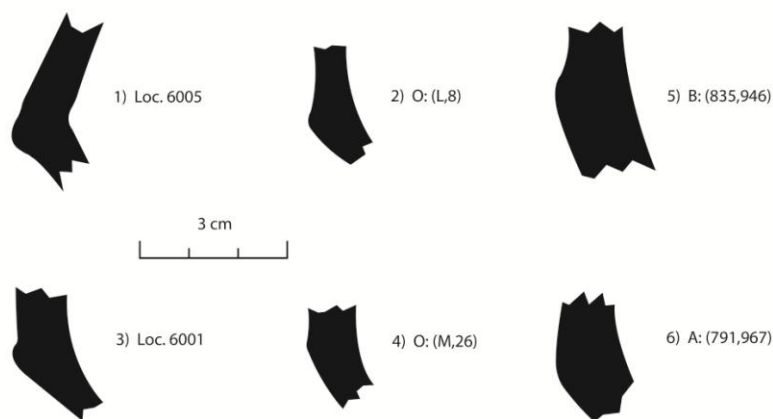


Figure 6.11. Characteristic profiles of body sherds with cut bases and coil-built bodies. Adjacent text represents the provenience of the sherds: their excavation locus, or their surface collection and collection grid square. Lacking rims or complete bases, the orientation of the sherds is approximate.

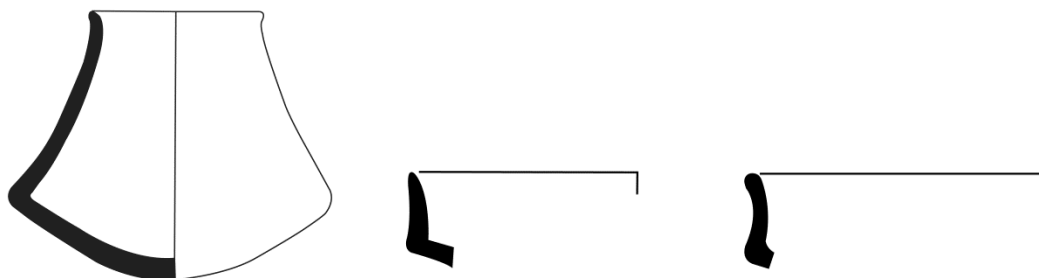


Figure 6.12. Left: Grey/Black Aksumite ware from Aksum (adapted from Wilding and Munro-Hay 1989: 309). Middle and right: medieval carinated pots/bowls from Meshala Maryam excavations (adapted from Chuniaud 2012: 255).



Figures 6.13. Modern carinated cooking pot with lid, decorated for tourists, see also "everted form" rims below.

The second style is frequently seen on rim sherds (see Appendix E, "Open Rounded Rims" and other examples). Here the coil-built section is often a low, rounded, open to vertical wall over a wide, shallow base that has been cut to shape. The overall profile is a more open and round one, lacking the prominent shoulder or ledge. Frequently, the cutting processes clearly trimmed the base much thinner than the coil built wall and may be responsible for the pattern of breakage at these weak points often seen in these sherds. More frequently than in the first style, the cut portions of the second style have been smoothed after cutting, leaving only secondary clues like the flat angle and thin base to indicate clay was cut away. In addition to the 26 sherds discussed above, a further 122 body sherds with cut exteriors were recovered from all collection contexts, including surface collection L, accounting for seven percent of all sherds subject to multivariate recording.

### 6.11. Plastic decoration

Burnishing, slipping, and slipping and burnishing were by far the most common decorative technique, observed in every recovery context. Of 1,031 sherds where at least one surface was intact for recording, 79% were either slipped, burnished, or both (Table 6.2). In all rim sherds, if a face was slipped, burnished, or both, the lip was as well.

While initial impressions were that surface collection L, possessing more recent and therefore generally better-preserved ceramics, would have a higher frequency of slipped ceramics, the frequency of all three treatments is comparable across all recovery contexts. Some surface collections have a slightly lower percentage of slipped ceramics, though they also have a high percentage of faces recorded as too eroded for identification and most likely plowzone processes are responsible for any discrepancy.

Table 6.2. Frequency and location of burnishing and slipping (n = 811). "One side" designates ceramic sherds where interior/exterior sides were indeterminate; in parentheses is the sum of "one side" plus interior treated and exterior treated.

	Interior	Exterior	Both Sides	One Side
Burnished (n = 595; 73.4% of total)	35.9%	30%	14.3%	19.8% (85.7%)
Slipped & Burnished (n = 203; 25% of total)	31.5%	37.9%	12.8%	17.7% (87.2%)
Slipped (n = 12; 1.6% of total)	23.1%	53.8%	0%	23.1% (100%)

Slip colors were comparable to paste colors ranging through oranges, reds, browns, and oxidized blacks. Darker or lighter shades were probably a product of firing rather than slip source. Brown slips made up roughly half of all slips, while reds made up a third (Table 6.3). Tsehaynesh claimed that red slips are made from clay gathered some distance from Gännäta Maryam. Brown slips are often the same color as the vessel, suggesting they are probably of the same source.

Table 6.3. Frequency of different slip color (n=191).

Orange	Red	Dark Red	Brown	Dark Brown	Black
2.1%	28.8%	2.8%	28.7%	23%	16.2%

Sgraffito, the process of decorating sherds by incising lines on fired (or possibly completely dried) ceramics, was the second most common decorative motif, though with only 37 examples, sgraffito is found on only 2% of sherds subject to multivariate recording (Table 6.4). Despite the low percentage, however, sgraffito has an extensive history of use in Ethiopian ceramics (e.g. Phillipson 2000: 326, Figure 262, 327, Figure 282; Chuniaud 2012: 253; Tesfaye, n.d.: Figures 10 and 12). Sgraffito decorations were frequently simple line or chevron patterns (Figure 6.14), often around the rim of vessels

and on burnished or slipped and burnished surfaces with three exceptions. Notably, sgraffito was exclusive to historic wares. Neither contemporary wares, nor any ceramics made by Tsehaynesh or other local potters seen in the market employ the technique; rather, they incise the leather-hard clay prior to firing. All but three examples of sgraffito were executed on burnished or slipped and burnished surfaces. The majority of sgraffito decorations were executed on vessel exteriors and/or only on one surface, though exceptions are not rare.

Table 6.4. Distribution of sgraffito decorated sherds by location, count and percentage per surface collection or excavation (n = 37).

Collection Location:	A	B	G	H	N	O	Unit 5	Unit 6
n =	5	1	6	1	3	11	2	8
Interior						1		1
Exterior	1		3	1	2	9		5
Lip							1	
One Side	4	1	4	1	2	11	1	6
Both Side	1		2		1			2
% of Sgraffito Collection	13.51	2.70	16.22	2.70	8.11	29.73	5.41	21.62
% of Analyzed Collection	1.41	0.76	6.25	0.60	1.23	11.1*	3.64	9.41
% of Total Ceramic Assemblage	0.27	0.11	1.83	0.31	0.24	1.77	1.36	5.67

\* Undecorated body sherds from this assemblage were counted along with the small class of sherds; thus, the sum for analyzed (the large class) sherds is overrepresented.

Other physical and/or decorative attributes were exceedingly rare. Besides the "sieves" discussed below, five sherds had punctures in them. One was most likely to repair a cracked or broken vessel while a second was in the base of a flat-bottomed contemporary ware. Two vessels with a cut base attached to a coil-built top had punctates impressed just above the joint, one with a small stick or reed, the other with a fingernail. An historic sherd of a similar vessel type had wider depressions like fluting rather than punctates. One contemporary ware with parallel incised lines appears to have been made with a comb. One bulbous-type rim (see Appendix E) had small wedges of clay haphazardly removed from the external edge of the lip, producing a crenellated effect.

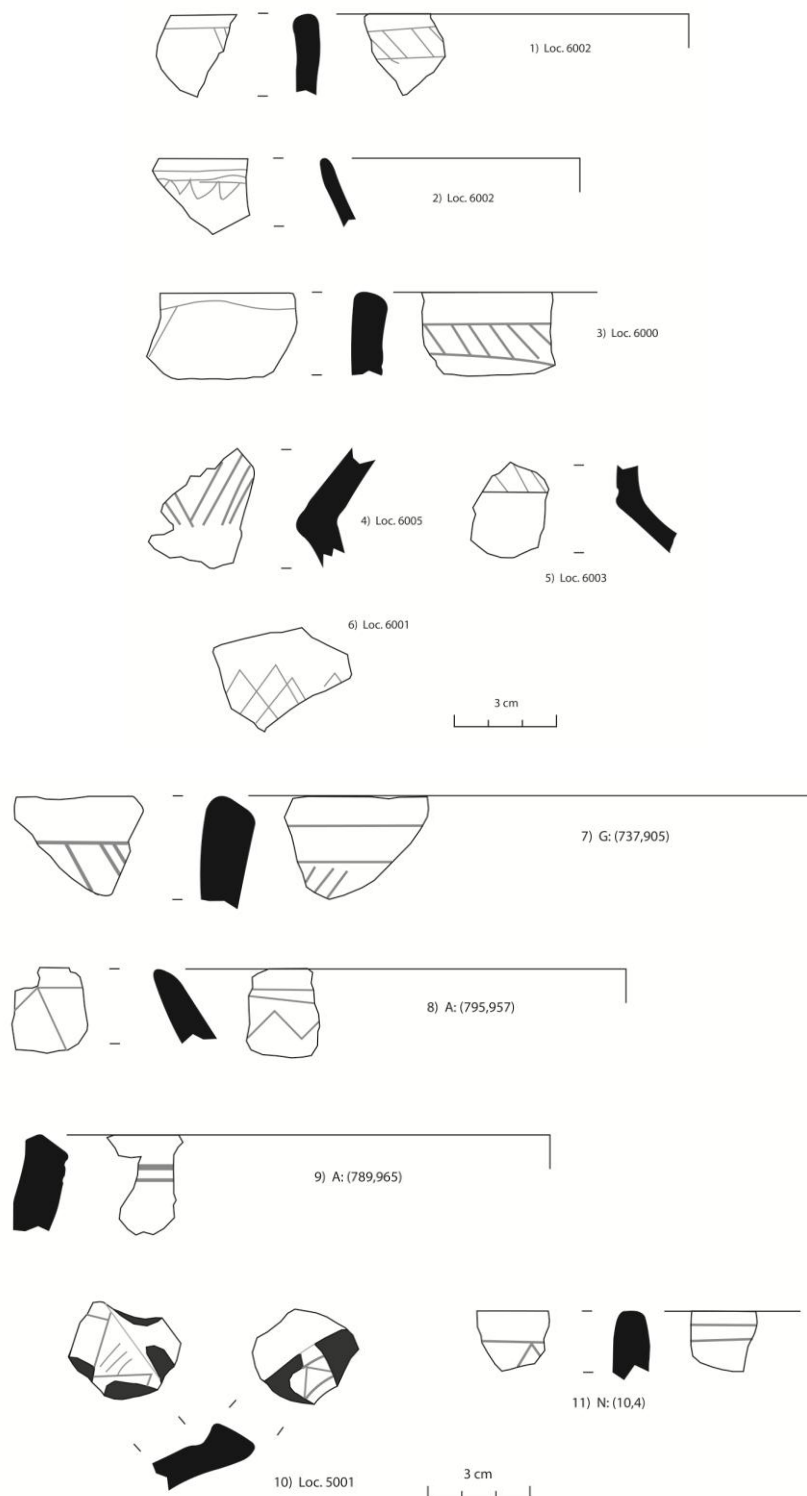


Figure 6.14. Examples of sgraffito decoration. Examples in the top half all originate from Kiflie Mado, Unit 6. Adjacent text represents the provenience of the sherds: their excavation locus, or their surface collection letter and collection grid square. The horizontal line from the rim with the vertical tail represents the radius of the rim.

Other decorative treatments were considerably rare. Five sherds had punctures through them, at least one likely part of a repair. Two examples had lines of punctates running across their exterior surface, one done with a reed or stick, the other with a fingernail. One example had fluted depressions running down the exterior above a cut base. And finally, one rim had small wedges removed from the exterior lip giving it a crenellated appearance. All are discussed in greater detail in the Appendix E.

### **6.12. Vessel types and rims**

A few vessel types based on function and numerous rim types were identified during analysis. The full, detailed description of each kind is available in Appendix E. The section here presents an overview of the types, their characteristics, and significance.

Four Fine Red Wares and eight additional sherds were recovered with series of regularly spaced and sized punctures placed through the clay prior to firing (Figure 6.15). All were flat, and like the Fine Red Wares, all were quite thin (avg. 5.9 mm). All were found in different collection areas. Dombrowski (1971: Figure 31) recovered nearly identical ceramic sherds from Lalibela Cave near Lake Tana, and identified them based on ethnographic research as artificial covers for cultivated beehives.



Figure 6.15. Sherds termed "sieves" during excavation may have been used by apiarists (see Dombrowski 1971).

Twelve sherds from nearly every context but surface collection L were recovered and tentatively identified as *mogogos* or similar cooking griddles. Only three were rims. *Mogogos*, used for cooking *njera* bread, and similar griddles used for other foods, are ubiquitous household items characterized by their thick, round, flat body, and heavily burnished cooking surface. Those in the assemblage have an average thickness of 12.7 mm ( $1\sigma$  1.6 mm). Eight of 10 subject to multivariate recording have 5%-20% sand or *geha* temper, above the average for other sherds.

On average, rims accounted for 5-10% of large sherds recovered from surface collections and often more in excavations, though such contexts frequently had far fewer sherds overall. Rim types are divided into five broad classes: open, closed, vertical, everted, and flat to shallow-open (Figures 6.16-18). Variation within each category is often great, however, so no class strictly represents a single functional vessel type or entire form. In some instances, features like rim diameter or aspects of the rim intimate overall vessel form, making later aggregate analysis discussed in the Appendix E easier. At the very least, however, such features demonstrate that these classes contain two or more ceramic types destined for different functions. Unfortunately, the fragmentary



nature of the sherds and the absence generally of any very large or refitted sherds impedes positive association between sherds and overall vessel form.

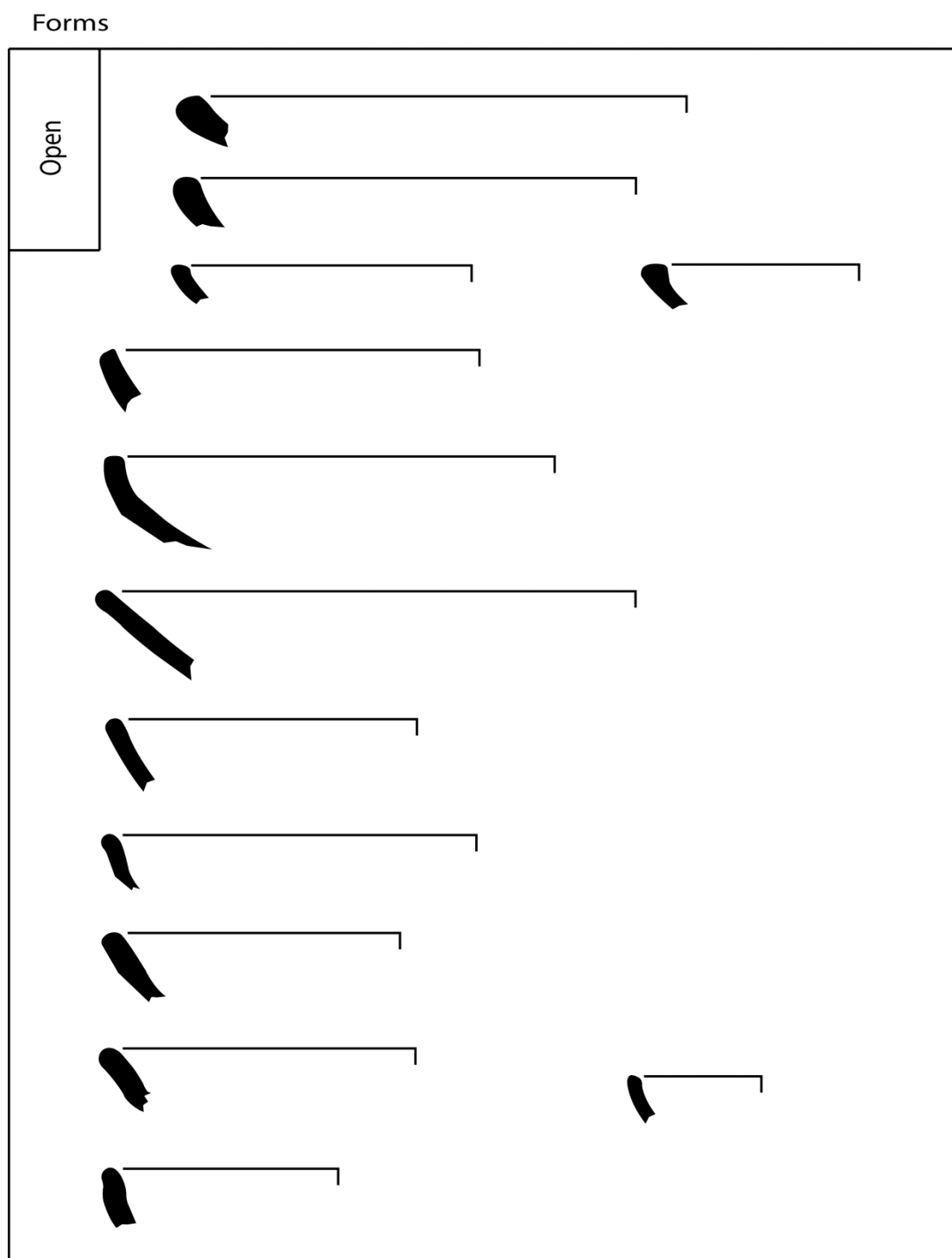


Figure 6.16. Sample of open rim profiles. The horizontal and vertical line represents the rim radius. All rims are shown at 55% of their original size.

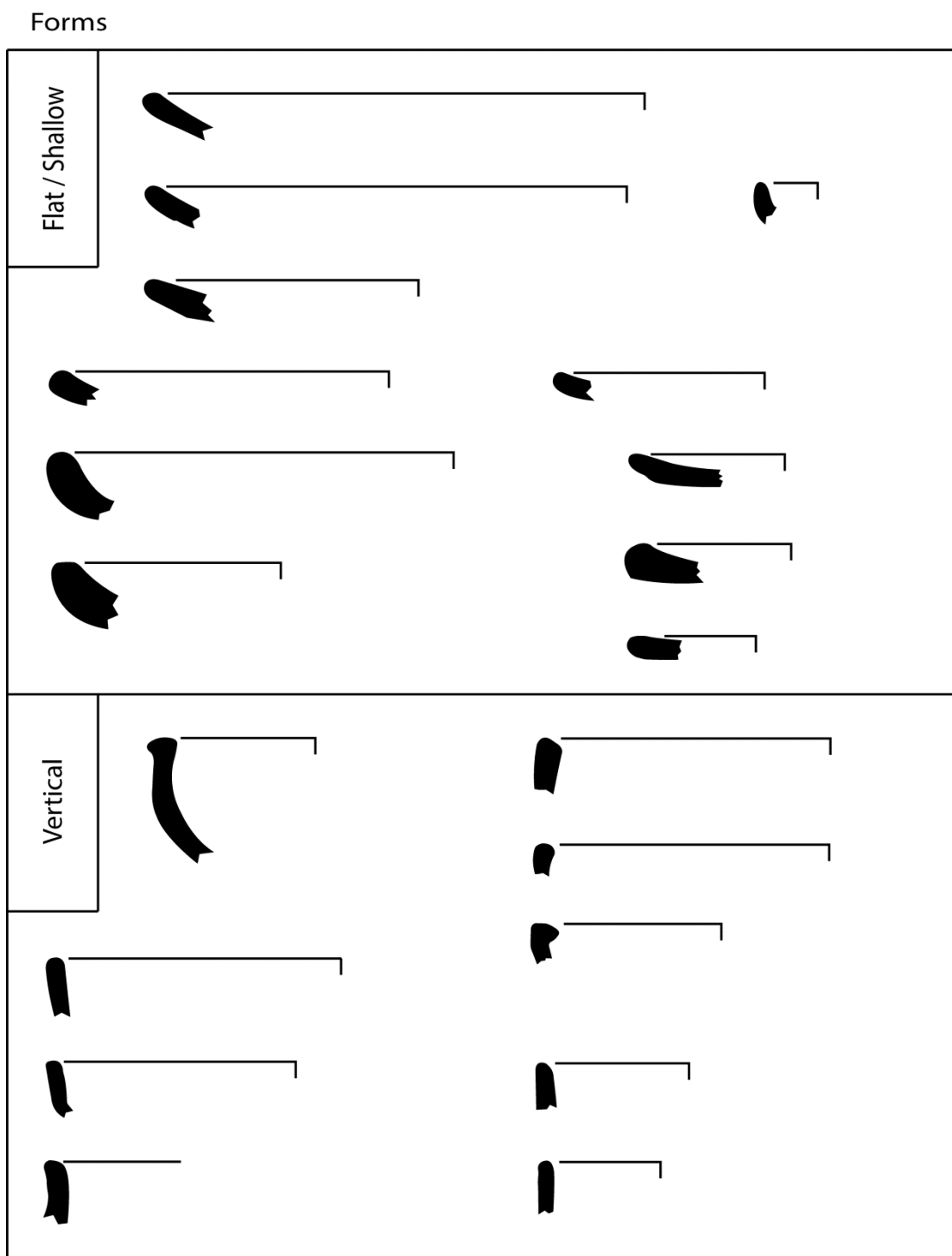


Figure 6.17. Sample of vertical rim profiles and flat/shallow rims.

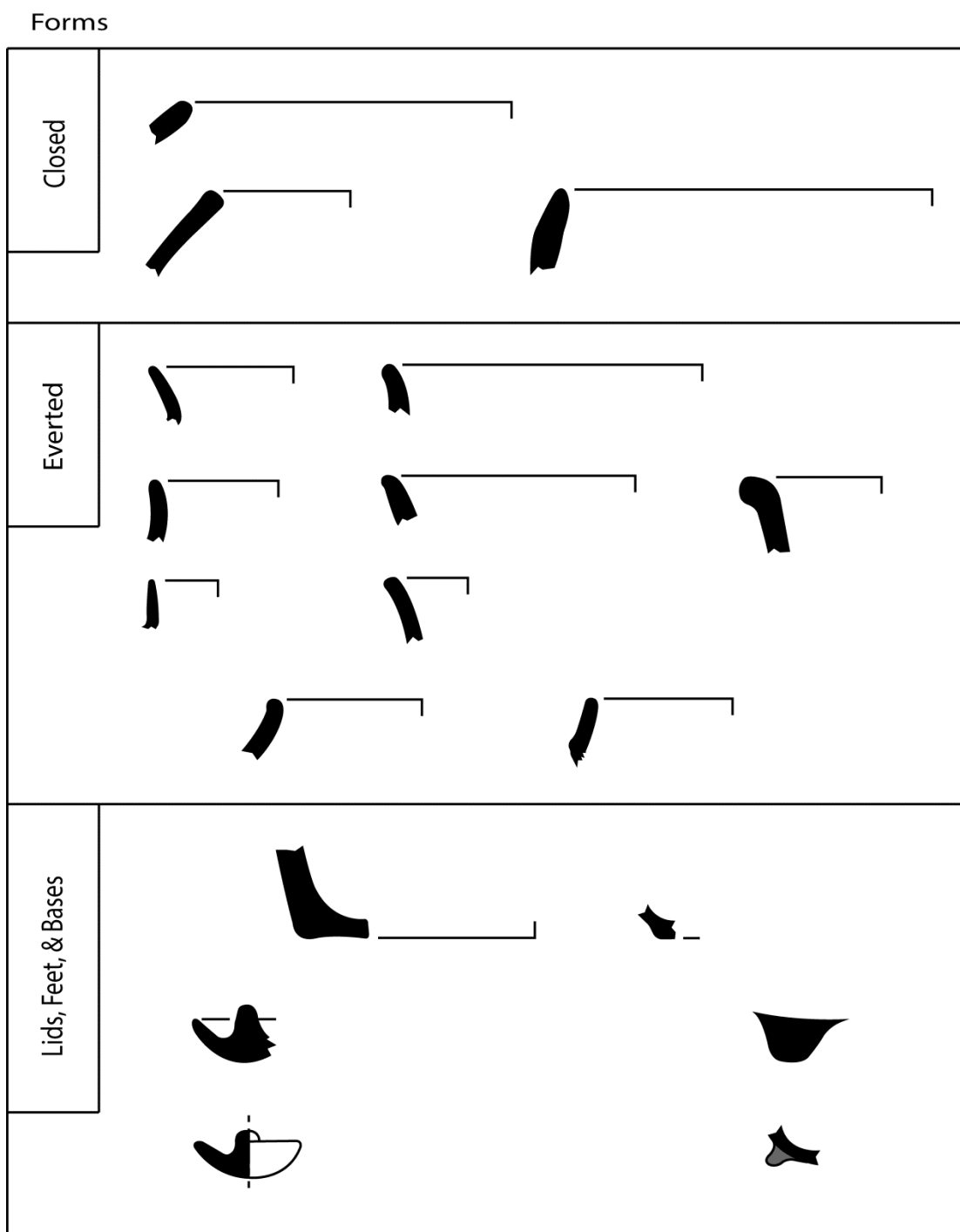
























































Figure 6.18. Sample of closed and everted rims, lids, feet, and bases. The bases shown here are flat ones, found in both contemporary and historic wares, though the majority of bases were likely rounded.

Table 6.5. Distribution of rim categories by collection area and context, and percentage of rims among the assemblage of large sherds from that context. \*Undecorated body sherds from surface collection O were counted with the small sherds, so the percentage of rims is inflated.

		Open	Vertical	Closed	Everted	Flat / Shallow	Rims / Collection Assemblage = Percentage
Tabot Madera	A						36 / 355 = 10.1%
	B						12 / 132 = 9.1%
	E						2 / 65 = 3.1%
	I						5 / 50 = 1%
	J						4 / 77 = 5.2%
Alem Doret	H						14 / 167 = 8.4%
	L						17 / 189 = 9%
Tarla Terrara	G						6 / 96 = 6.3%
	4						2 / 39 = 5.1%
	5						19 / 50 = 38%
Agay Midir	N						17 / 244 = 7%
Kifile Mado	O						36 / 115 = 31.3%*
	6						16 / 85 = 18.8%
	7						6 / 29 = 20.7%
	8						2 / 15 = 13.3%
n =		103	31	16	14	30	 = 2

Open sherds comprise a number of variations on bowls and basins ranging in size from a few centimeters to 30 or more centimeters. Most have a rounded profile, while others have much flatter sides, usually with a wider diameter. A number also show

evidence for cutting of the base. Open rim profiles were the most common in total and within most collection contexts. Commensurate with their quantity, they show a wide variety of surface treatments, tempers and other characteristics. With the frequently small rim fragments recovered, however, it is hard to subdivide and generalize this class further, though an attempt is made in the Appendix E. A few open rims were tentatively identified as lids like those used on cooking pots, based partially on flatter sides and wear around the lip, though in no cases could this be confirmed with certainty and there appeared to be little if any pattern in tempering or surface treatments.

Closed rims were one of the rarest vessel forms, though they were found in most contexts from all areas of the site. Their diameter and features such as temper and decoration vary, but are comparable to open vessels. The rims suggest a globular vessel form and may have been used in a variety of contexts from food service to storage.

Vertical rims were the second most common vessel type and were equally as diverse as open rims. Most rims were not oriented toward a true 90° angle, but were within  $\pm 10^\circ$ . In size, composition, and decoration, they appear as diverse as the open rims. Those with a rim slightly greater than 90° are similar in form and composition to many of the open bowls, while those with a slightly restricted opening appear similar to the globular form of the closed vessels. A set of rims with near true vertical profiles generally had diameters less than 20 cm, and as little as ~5 cm. They all also have 5% or more of sand or *geha* temper. The smaller ones are probably related to the globular pots frequently used today and in the recent past to store spices and other fine dry goods, while the smallest may represent the *jebena* coffee pots. Larger forms may be large jars and pots like those used to brew beer and hold water. One example from Kiflie Mado with an 18 cm diameter aperture and rounded body came from the living floor in Unit 8 (locus 004) and is identical to the cooking and food service pots made today by Tsehaynesh (upper left of the "Vertical Forms," Figure 6.17); the premodern local equivalent being those vessels with the cut base and protruding shoulder.

Everted vessels represent two styles, an open vessel form with an everted lip, and a closed vessel body with an everted lip. Together, they represent the least common rim form. Those with an open form were found in many contexts throughout the research area, though often no more than one or two were recovered from any context. In

diameter and composition, they are identical to the vertical rims with the near vertical orientation. They are very likely another rim form representing a range of necked jars and pots like those used for brewing beer and storing water in the larger sizes, and storing spices and other dry goods in the smaller sizes. The closed forms, of which there are only two examples, both come from Kiflie Mado and may represent a rim style unique to that area within the study area, but perhaps similar to other regional vessel styles like those recovered from Meshala Maryam (Figure 6.12 above, and Chuniaud 2012).

Flat to shallow vessels were nearly as common as the vertical rims, but were strongly localized at Kiflie Mado. In size and style, they vary greatly. Larger ones with diameters between 30 and 50+ cm and large volumes of temper are interpreted as *mogogo* and similar cooking surfaces. A few thinner ones of similar diameters may be serving platters where *njera* is transferred after cooking and food is ladled otop for group consumption. The five flattest sherds (three depicted in bottom left of "Flat / Shallow Forms," Figure 6.17) with diameters of about 15 cm and slightly less were recovered from Kiflie Mado and may be pot lids for large storage jars.

The final rim types were rounded pot lids, resembling tops. Only two confirmed examples were identified, though I suspect some small, open rim fragments may also be partial lids. Both lids were found at Kiflie Mado, though the style has been recovered in medieval contexts (Chuniaud 2012: 257) and is still in use today (e.g. Figure 6.4 above).

### 6.13. Conclusion

The ceramic assemblage at Gännäta Maryam incorporates a range of forms and attributes, though the palimpsest nature of the area greatly reduce the utility of the assemblage for addressing interpretations of the area's history. The collection appears to represent a rather conservative ceramic tradition probably manufactured for local consumption and utilitarian use. With the minimal and poorly preserved contexts, temporal questions and the establishment of a chronology are largely precluded, except for the transition from historic to contemporary wares. Spatial distributions of material are easier to identify, though the significance is not clear. The following interprets and summarizes the assemblage as a whole based on the above analysis and attempts to

provide some context to the assemblage within the history of Gännäta Maryam and Ethiopia at large, and within the context of landscape formation processes.

As should be clear by this point, the primary difficulty of working at Gännäta Maryam and areas like it is the absence of stratified or well-preserved archaeological contexts and features. This hampers attempts to study chronological change in the assemblage. Nonetheless, with dates associated to some features like the pits at Tarla Terrara, the hearth at Kiflie Mado and associated occupation, and the recently abandoned home at Alem Doret, there are dated benchmarks stretching across a maximum of 300 years against which the undated surface collections can be compared. Despite this possible range of dates, the assemblage does not appear to demonstrate great change in any variables over time with the exception of the changes seen in contemporary wares. By contrast, there do appear to be some patterns in the spatial distribution of certain variables, though the significance of this distribution is unknowable at this time.

Rim profiles provide perhaps the most readily distinguishable and categorical feature of the assemblage. Rim profiles, of course, do not necessarily correlate exclusively to overall vessel form and function, as demonstrated by the wide variety of possible vessels represented in different rim diameters and paste compositions discussed above and elaborated in Appendix E. A more complete reconstruction of vessel forms would be better suited to studying temporal change and spatial patterns, but is clearly impossible with this assemblage. With the limitations of this assemblage, there does not appear to be any appreciable chronological change in vessel forms over time because most rim types are found in a diversity of dated and undated contexts. This suggests that while the collection areas represent 300 years or more of history, there may have been few if any major changes in ceramic forms. More subtle changes to decorative preferences and vessel profiles may have occurred, though such details are difficult to pick out in this fragmented and degraded collection and could merely be the result of the hands of different potters. Regardless, the overall impression is of a ceramic tradition that has remained fairly constant, with a few exceptions, over the span of time represented by the majority of the assemblage.

Other features also appear fairly consistent over time and space. Temper preference, degree of oxidation, and decorative treatments appear to be fairly consistent

across contexts. When examined by contexts as a whole, relative use of tempers was fairly consistent except for a possible preference for *geha* in certain contexts. Only volume of temper appears to be a good chronological marker, but only for distinguishing some ceramics produced prior to and following the 1970s land reforms that dispossessed some potters from their preferred clay sources. Other potters may have been lucky enough to keep their clay sources, and so the behavioral changes in ceramic production experienced by Tsehaynesh and observed at Alem Doret may not be consistent across the region.

There also do not appear to be changes in preference for oxidized or reduced ceramics, or in the technologies and care in their production. Likely then as today, customers desired an availability of both black and oxidized wares. Demand for precision oxidation or reduction though was not great, as many sherds are poorly oxidized or reduced, and often possess spots of one or the other. The same pattern and practice appears common today following observations of Tsehaynesh and the local market, suggesting that preferences and production techniques for firing have changed little. This is not to imply that certain vessel types were not necessarily preferred in one color or another, and that this may have changed with time. Again, however, the preservation of the Gännäta Maryam material and its temporal and spatial contexts are too disturbed to readily investigate this.

Decorative patterns also appear fairly constant over time. The presence of slipped versus unslipped vessels, or slipping with and without burnishing, for example, did not appear to differ significantly across contexts beyond what could reasonably be explained through degradation in plowzone contexts. Casual observation of Tsehaynesh's pottery showed a high frequency of slipped ceramics, though slipped wares were not quite as frequent in the local market and generally appeared more consistent with the ratio seen in the archaeological assemblage.

The only plastic decoration to show clear chronological change is sgraffito. Sgraffito is found exclusively on historic wares and archaeological contexts throughout Ethiopian history. Incision was found on only one sherd, a contemporary ware from Alem Doret, though all of Tsehaynesh's ceramics and those at the local market employed incising rather than sgraffito. One possible explanation for the change from sgraffito to



incision is the easier production and ability to change mistakes. Faced with the declining economic viability of pottery and inaccessibility of suitable resources, the decision might be a way to save time and improve visual quality. Other plastic decorations like punctates, which are made on wet, unfired ceramics, may convey some chronological data, but examples were too few to draw such conclusions.

One plastic decoration of possible temporal significance conspicuously absent from the assemblage is the presence of crosses and motifs resembling Ge'ez/Amharic syllables. Cruciform motifs and Amharic characters molded or scratched onto ceramic bodies have been noted in many historic assemblages dated to the middle of the second millennium and earlier (e.g. Wilding and Munro-Hay, 1989: 297; Phillips 2000: 327; Poissonnier et al. 2012: 142; Tesfaye unpublished; Mengistu unpublished) across Ethiopia in all directions from Gännäta Maryam. Though no one has investigated the matter, the presence of the cruciform motifs may be related to the Christian zealotry of the Middle Ages when Ethiopia was regularly in conflict with Muslim and pagan neighbors. Emperor Zara Ya'eqob (r. 1434-1468) mandated citizens wear crosses and display them around their homes as proof of their Christian identity (see Tamrat 2009[1979]: 239). Since such motifs are somewhat common in ceramics from sites in the early to middle second millennium (no excavations appear to have investigated material more recent than the 18th century or so), their absence at Gännäta Maryam, seat of a notable royal church, may be a good chronological indicator of a late second millennium date.

Evidence for chronological change in the artifact assemblages at Gännäta Maryam then is hard to discern. While certain features may hold some temporal significance, the ceramic assemblage from Gännäta Maryam is too fragmentary and contexts too limited to develop a chronological schema or seriation of the assemblage. Returning to the notion of the landscape as a palimpsest, processes like plowing and erosion have evidently conflated too much of the region's history into mixed surface or near-surface materials. Only isolated features like the ash heap or Tarla Terrara pits have remained, while surrounding archaeological contexts that might give them greater meaning have been erased. What material they retain is too fragmented and spatially and temporally isolated to piece back into a wider picture of local history. The cumulative palimpsest at Gännäta

Maryam, then, in addition to the destructive formation processes such as plowing and trampling that have fragmented ceramic sherds, has effectively collapsed most of the area's temporal resolution into a single block of time spanning 300 years, possibly more. Only among the most recent contexts tied to living memory is temporal reconstruction apparently possible. Older material may require research beyond the study area to gather data necessary for further, more detailed, interpretation.

While the chronology of the assemblage is exceedingly difficult to interpret based on the available remains, spatial distribution patterns are more clearly apparent and perhaps meaningful for local history. The general distribution of some materials across all contexts and the limited distribution of others, for example, may reveal some information about the nature of the sites and consumption patterns. However, like the interpretation of chronological data, the palimpsest nature of the region does limit the length to which any interpretation can be extended due to the dearth of intact archaeological contexts.

As mentioned above, many ceramic variables like rim profiles were fairly well distributed across different contexts suggesting minimal change over time. Exceptions to this distribution were the Fine Red Wares, the contemporary wares, and some of the unique profiles and subtle differences in features of the Kiflie Mado ceramics. The even distribution of most rims further supports the theory set out in the discussion of the Alem Doret *tukul* survey in Chapter 5 that many of the surface artifact scatters are not in fact part of one large single site like a royal camp, but are the remnants of small domestic sites which have since been abandoned and their traces dispersed by plowing and other behavioral and natural processes. Just as the artifact distributions of other localized ceramic scatters are similar to the Alem Doret *tukul* site, so are the types of ceramics similar across each scatter. This supports the interpretation that the sites were all similar sites to the *tukul* habitation, e.g. similar subsistence agricultural inhabitations or various other socio-economically similar residences.

Three exceptions appear to stand out from the general homogeneity of the ceramic assemblages across the study area. One, the localized presence of Fine Red Wares in the northeastern area of Tabot Madera is notable. The reason for this concentration is unknown, but may be indicative of a number of causes. For example, the Fine Red

Wares could be a chronological marker, having only been available to residents during a certain period of time, and thus only appearing in archaeological assemblages from that time. Alternatively, they could represent a family or a few families that had access to or need of some exotic or specialized ceramic. In such a case they may relate to social or economic status, or occupational specialization. Because Quinn (2013) did not note anything unusual or exotic about the paste of these ceramics, it is possible they were made in the region. Perhaps they were made in another village and acquired there or brought with a family. It is not uncommon for young men to seek out brides from other villages, or for men to move to other villages if or when family land holdings become too small to divide among a family's children (see Hoben 1973). Tsehaynesh, for example, explained how she grew up a few kilometers northwest of Lalibela, and only moved to Gännäta Maryam after her family betrothed her to a suitor from Gännäta Maryam. Presumably such geographically dispersed families maintain contacts with one another and may likewise transfer goods.

Second, there are also numerous distinctive traits and minor subtleties in the ceramics from Kiflie Mado not shared with the rest of the study area. Some subcategories of flat rims and open rims (subcategories: bulbous rims, Type 2 Open, Rounded rims, and Type 2 Open, Everted rims) discussed in the Appendix E, for example, are all exclusively found in the Kiflie Mado contexts. The Type 2 and everted rims share enough similarities in form and diameter with their broader rim types that they may represent similar vessel forms. The bulbous rims too, like the one mentioned and pictured above in Figure 6.17, are hypothesized here to be the same sort of cooking pots still in use as seen in Figure 6.1. Intuitively, there also seem to be minor differences in the sgraffito designs from the Kiflie Mado sherds compared to the others. There are the parallel lines with hashes on the sherd from Locus 6003 and the parallel lines over chevrons from Locus 6002, not seen elsewhere, for example (compare the upper and lower halves of Figure 6.14). All these differences are notable, but perhaps not unexpected. If the site was that of a potter as remembered in the local history, then presumably the majority of ceramics found there would have come from the resident potter or family of potters. The stylistic differences, then, identify the unique hands of one person or family while the assemblages from the rest of the research area almost

certainly represent pottery acquired from a number of potting families, probably also from different time periods, and thus minor variation in style are expected.

The exclusive presence of these pots at Kiflie Mado may also have implications for better understanding trade networks and how artifacts like pottery moved across landscapes in their systemic context. While identifying ceramics of Kiflie Mado origin elsewhere in the study area was not an explicit goal during analysis, the analysis appears to suggest that the ceramics produced there did not move to the other study area terraces in large quantities. This may be merely a temporal matter, the other artifact scatters pre-dating the occupation of Kiflie Mado. However, it is also possible that pottery moves horizontally across terraces rather than laterally among higher and lower elevations. This seems sensible given the steep and unstable paths that link some of the higher and lower terraces compared to the much more level and stable ones linking paired terraces of the same elevation. The radius of distribution of pottery from a pottery production locus may also be a factor. Perhaps potters like Tsehaynesh and others reportedly serving the Gännäta Maryam area are proximate enough to the residents that buy from them that there was no value in transporting Kiflie Mado products so far, particularly prior to the growth of the centralized village. Rather, perhaps each potter serves a radius of people around them, even restricted to only those at the same elevation, that would limit the extent pottery might normally travel except in possibly rare circumstances.

The third and final notable spatial distinction among the ceramics is the abundance of contemporary wares at Alem Doret and their relative absence elsewhere. As temporal indicators of post-1970s occupation, their isolated presence at the Alem Doret *tukul* site suggests all other artifact scatters very likely predate the land reforms that affected local pottery production. This is supported by the aerial imagery which does not record any habitations in areas with artifact scatters following the earliest image in the mid 1960s.

While there are notable patterns to spatial distribution of some ceramic materials, then, their meaning is not quite clear. Formation processes have disturbed contexts too much to study material spatially and temporally, or to make sense of their location, preventing a detailed analysis of the relationships between sites, features, and artifacts. While the assemblages are often spatially discrete enough to isolate one from another, the

loss of their original contexts prevents further analysis beyond the formation of cursory hypotheses. Such disturbed contexts as these at Gännäta Maryam then beg more questions than they answer in nearly all regards. What does seem clear, however, is that the similarity of the sherds across contexts and times suggests continuity up to the contemporary living landscape at Gännäta Maryam. Rather than some unusual site like a work-camp related to the construction of Gännäta Maryam, or a royal camp as remembered in oral history, the archaeological remains that have survived down to the present almost certainly represent the historically recent pattern of isolated homesteads occupied for some time, then abandoned and gradually erased by behavioral and natural processes. Some locations and features like those found on Tarla Terrara may represent something fundamentally different, though the erasure of details from local formation processes may stymie the interpretation of these isolated incidences unless and until better preserved examples can be found elsewhere where formation processes have been less destructive.

## **Part II: Lithics**

### **6.14. Flaked stone tools**

Relative to ceramics, lithics made up a small portion of the total artifact assemblage. Flaked stone artifacts were the most common lithic class, though other lithic objects were also recovered. The small volume of lithics my team recovered does not lend itself to interpreting site formation processes as readily as the considerably larger ceramic assemblage. As mentioned in the previous chapter, the dearth of lithic material may be related to formation processes that have selectively destroyed at a greater rate or differentially distributed lithic material such that it was not as prevalent where other artifacts like ceramics were highly visible. Unfortunately, time constraints prevented a detailed analysis of the lithic assemblage, though an inventory and notes were made by myself and Dr. Jacke Phillips. Regardless, the lithic assemblage does offer some

interesting questions for consideration in future research. Tables 6.6 below provides totals of flaked stone artifacts recovered from surface collections. In addition, 36 lithics were recovered from excavations: two from Units 1 and 2, 21 lithics from Unit 4, and 11 from Unit 5.

Tables 6.6. Table showing the number of lithics by collection area, and frequency of their distribution (n = 228).

Surface collection	A	B	D	E	F	G	H	I	J	L	N	O
n =	32	20	4	17	5	20	29	7	11	61	18	4
# of collection units	100	75	100	50	75	72	50	25	70	74	72	88
% of units with lithics	32%	26.7%	4%	34%	6.7%	27.8%	58%	28%	15.7%	82.4%	25%	4.5%

Flaked stone artifacts recovered from Gännäta Maryam are composed of three stone types: chert, opaque chalcedony, and obsidian. Small pieces of chert and translucent white chalcedony outcrop regularly in the study area and wider region and were common finds during regional surveying undertaken in 2009. Most natural chert and chalcedony finds, however, were small nodules and stones only a few centimeters in diameter and may not be indicative of the sources of material for the lithic artifacts recovered in the research area. At Gännäta Maryam the only localized source of suitably sized chert we encountered was a poor quality yellow-brown chert found on the southwest peninsula of the lower terrace. This chert had very poor knapping qualities, however, and does not seem to be a source material in the artifact assemblage. Obsidian artifacts were also found in the study area, though neither I nor my team are aware of any source around Mount Abuna Yosef in the regions of Gännäta Maryam or Lalibela.

Because much of the archaeological work at Gännäta Maryam was by way of surface collections, the lithic assemblage has suffered greatly from post-depositional damage. Most lithics were quite small, less than one centimeter at their widest, and showed clear signs of shattering and fracturing due most likely to post-depositional processes such as trampling and striking by plows. When evidence for the original knapping process was preserved, side scrapers made from flakes of different kinds were

found and appear common. Very small (< 3 cm) discoidal scrapers were also found as well as at least one lunate-shaped backed blade made from a prismatic blade. Obsidian was most frequently found as small shattered fragments likely resulting from destruction during use or following discard, but at least a few appeared to be remnants of prismatic blades and other knapped lithics from prepared cores. Incidentally, however, cortex was noted on a number of utilized flakes, including obsidian, perhaps suggesting a degree of expediency or parsimony practiced by the knappers.

Based on cursory observations, the distribution of different lithic materials appeared even, with one exception. Knapped flakes of a pale green, opaque chert were observed in particularly high concentrations on Alem Doret. The reason is unknown, but may hint at a temporal factor or special access to the raw material by the Alem Doret *tukul* or *nas* residents. Alternatively, the concentration may be the result of more recent recycling. Twice I observed the green chert flakes collected in the cups of *gebeta* (mancala) boards fingered in the soil on Alem Doret, mentioned earlier in Chapter 3. While use by children may not entirely explain the concentration of green chert in the area, such collection and recycling likely has some effect on its visibility and distribution.

It is also notable that surface collections on Alem Doret, particularly the *tukul* survey, surface collection L, had the densest concentration of lithic material (Figure 6.6), twice the volume found in the second largest collections of surface collection A and H, both of which had more collection units than the *tukul* survey. Surface collection H, however, is also on Alem Doret, and like surface collection L, is likely associated with a recent occupation there, the stone *nas*. These concentrations support the theory that lithics continued to play a strong role in daily life into the recent past and may continue through the present. The one exception appears to be surface collection O, which I have also argued is relatively recent compared to the other surface collections yet it has the second lowest concentration of lithic material. With its association to metal working, however, perhaps the occupants were able to make more frequent use of metal alternatives to stone. Alternatively, the very steep grade of the area may have contributed to the selective removal of such artifacts as discussed earlier.

*Ato* Dejene and Setegen Demele both claimed that the use of stone tools for minor needs like cutting rope was common in the past and may continue today, though they felt

that the availability of metal tools today had largely replaced the use of stone. They also claimed that while hide working for high quality leather like that made by the Lalibela manuscript makers probably does require special tools like hide scrapers, most farmers preparing roughly fashioned rawhide skins for general use are just as likely to use a coarse stone or metal knife. Though the topic was not discussed at length, the interviewees did not give the impression that lithic tools were particularly valued or made for special purposes. While some tools like those derived from obsidian blades probably held some value due to the complexity of their production, the dismissive tone with which interviewees discussed the stone tools may support our initial impression that many of the lithics are expedient flakes made with little or no systematic reduction or retouching.

### **6.15. Miscellaneous lithic materials**

Two pieces of chalk were recovered, one from surface collection O on Kiflie Mado, and one from surface collection L at the *tukul* site. Both fragments appear to be modern commercial chalk and were worn down from use to miniscule nubs. They may date to the original occupations of both sites; the Alem Doret *tukul* at least was inhabited during the construction of the local school in Gännäta Maryam Village. Alternatively, they may be unrelated to the sites and were dropped or discarded by local children.

A grinding stone fragment weighing about 1.3 kg was recovered from surface collection A. The concave face of the fragment indicates it was the quern, or grinding surface. It is made of an unidentified mineral, probably a coarse trachyte or basalt. While expectations were that grinding stones would be more common in the surface collections, local traditions recovered from the ethnographic portion of this project indicated multiple forms of recycling of such artifacts. Therefore the dearth of grinding stone fragments may not be exceptional.

A small stone ball pecked from the same red stone as Gännäta Maryam Church was recovered from Locus 6003 (Figure 6.19). The ball weighs 30.1 grams and has a circumference of about 28.9 mm. Dombrowski (1971: 134) reports finding similar stone



balls at Netchabiet cave. Her ethnographic research in her study area records that such balls were used as weights for measuring cotton, a product not currently grown at Gännäta Maryam, but observed in trade at Lalibela. At 80+ grams, however, Dombrowski's balls are larger than the Gännäta Maryam example. Pankhurst (1970:51-53) discusses presumably similar stone weights made in Ethiopia for measuring cotton, as well as the use of coins as weights, and the production of stone weights equal to the weight of Maria Theresa Thalers, a currency in 19th and early 20th century Ethiopia. At 28 grams ([britishmuseum.org](http://britishmuseum.org)), a Thaler weighs nearly the same as the Gännäta Maryam ball, and so its identification as a stone weight for commerce is reasonable. Its presence in the ash midden, however, seems unusual.

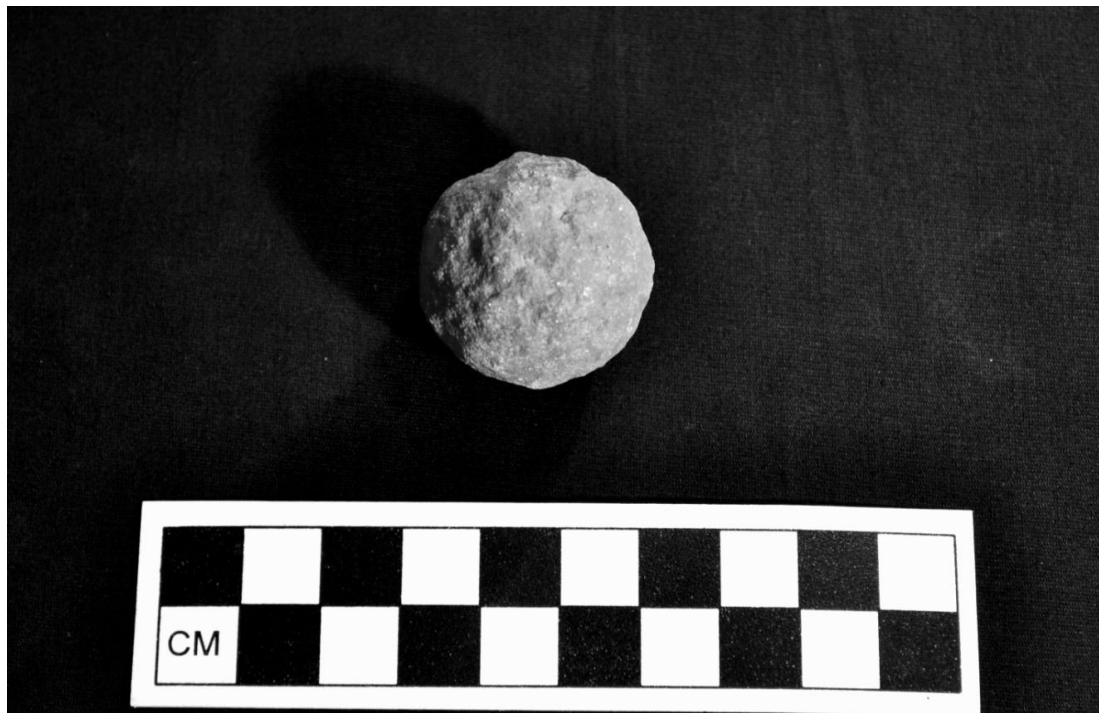


Figure 6.19. Pecked stone ball recovered from Unit 6, locus 003. Tentatively identified as a weight.

## **Part III: Faunal remains**

### **6.16. Faunal remains**

Faunal remains were recovered from both surface contexts and excavations. Preliminary analysis of the faunal remains was undertaken by Dr. Christopher Tribe (see Appendix D) and a more detailed analysis of the complete assemblage collected by the Solomonik-Zagwe Encounters Project is in progress. While Dr. Tribe has provided an inventory and notes on the faunal assemblage recovered from the study area, interpretation of the finds in the broader context of fieldwork is complicated by the lack of greater context for many recovery areas and features. As discussed in Chapter 4, the result is that interpretation of the use and cultural setting of many features and surface contexts is still largely unknown and thus explaining the relevance of the faunal remains to those contexts is purely speculative.

In the surface collections, faunal remains were infrequently encountered. Most often, these finds were fragments of hypsodont or selenodont tooth enamel. More rarely, we recovered splinters of heavily eroded and degraded bone. The tooth enamel fragments in the plowzone are likely of little archaeological interest. Animals like sheep and goats may lose teeth as they age and they have probably entered plowzone contexts through loss while grazing on agricultural stubble (J. Knouse, DVM, pers. comm.). All bone fragments recovered from the plowzone were too fragmentary and too aggraded to identify. Most likely, plowzone conditions are too dynamic and harsh for good bone preservation and bones may have entered the plowzone by any number of means, including being plowed up from archaeological contexts, discarded by contemporary humans, or moved by scavenging animals. Therefore, faunal remains in the plowzone at Gännäta Maryam probably hold very little information relevant to interpretations of the past, and the same likely applies to most plowzone contexts in Ethiopia.

By contrast, the semi-arid environment of the highlands appears ideal for preserving bones in well-preserved contexts like the pit features on Tarla Terrara and the preserved ash heap at Kiflie Mado where numerous bone fragments ranging in size from

sheep ribs to rodent maxillae were preserved in pristine condition. Excavation Unit 4, for example, preserved only one bone fragment in the plowzone, but 18 bone fragments in the thin layer of undisturbed soil between the plowzone and bedrock. Dozens of bones were also recovered from the pit features, Loci 4006 and 6008-9. The pit features are notable for their large quantities of sheep bones, particularly rib and long bones, and avian bones reminiscent of chicken, perhaps a local variety or wild francolin. Numerous other small rodent and bird bones were also recovered from these contexts.

Excavation of the pit feature in Unit 5 recovered similar remains, though bones of cattle and tooth fragments of sheep/goat may be more common. A few bones were even burned, likely resulting from inclusion in the same processes that produced the strata of ash they were found in and between. Like Unit 4, bones of other miscellaneous small, wild animals are also present.

Compared to Tarla Terrara, Unit 6, the ash heap on the surface of Kiflie Mado presented the largest assemblage of bones and is notable for its large proportion of avian bones and small, though not insignificant, volume of sheep bones, representing perhaps a wider variety of anatomical parts than represented in the Tarla Terrara assemblage. Several bones are also burned and/or show evidence for cutting and gnawing. Unlike the Tarla Terrara units, this feature contained few if any bones of the miscellaneous wild species seen in the Tarla Tarrara features.

Evidence for burning, cutting, gnawing, and the predominance of domestic or commonly consumed wild species like the possible francolin all suggest the bones from this midden originated from behaviors centering on food preparation and consumption. The ash heap itself, with its voluminous amounts of broken pottery, may be sweepings from a cooking hearth like that excavated in Unit 8 about 60 meters east, or a combination of domestic hearth sweepings, with ash from pottery and smithing activities commensurate with the presumed use history of the larger location. The function of the Tarla Terrara features and how the bones came to be there is more mysterious. While again the volume of domestic species may suggest the pits were used for disposal of food remains, the use of pits for the purpose seems unusual and the pits from Unit 4 lack the surrounding ashy matrix of Units 5 and 6. Disposal of trash also does not explain why so

many other avian and small mammalian species were found there, unless, perhaps, they were the remains of scavengers that unwittingly ended their lives in the features as well.

## Part IV: Metals

### 6.17. Metals

Metals here may be subdivided into two categories: iron, and iron slag. No other metals were encountered and Ababu Gubay claimed that no other metals were worked in the area in his memory, although churches in the area, including Gännäta Maryam, possess historic artifacts in gold, silver, and possibly bronze or brass. While iron objects were present in many contexts, Kiflie Mado was the only place we encountered slag. It is worth bearing in mind *Ato* Gubay's claim that rarely are metal objects discarded, but often brought back to smiths for recycling; this may contribute to the paucity of substantial metal finds in the area. Inventories of metal and slag objects can be found in Appendix G.

Two classes of metal objects were recovered from the larger of the two pit features (Locus 4008) at Tarla Terrara: metal wires and a metal nail. Five wires of various lengths and widths, though all quite small and exceedingly corroded, were recovered from the unit. Corrosion made accurate measurements challenging, and many appeared as though they had broken recently, possibly in screening. Average length was about 50 mm and diameter, 3-4 mm. They are here referred to as wires for simplicity, though they could have served many uses or been part of larger objects. A large nail was also recovered. Like artisanal nails seen in the market at Lalibela, this nail was composed of a long piece of square wire, one end wound tightly to form the head and the other tapered to a point (Figure 6.20).



Figure 6.20. Coiled iron nail from Unit 4, locus 008.

Aside from one small fragment of flat, rusted metal recovered in surface collection N, the rest of the iron artifacts were collected at Kiflie Mado. The ash heap at Unit 6 produced a small, thin bar of folded metal and a tightly coiled metal ring (Figure 6.21). A thin piece of metal with a hooked end was recovered in surface collection O. Finally, an oddly shaped metal object was recovered from the debris over the living surface excavated in Unit 8. This metal object (Figure 6.22) is a long, round wire with an end hammered flat before a tapered point. A small unidentifiable piece of heavily corroded iron scrap was also recovered in Unit 7.



Figure 6.21. Metal coil recovered from Unit 6.



Figure 6.22. Metal object recovered from Unit 8, locus 004.

During initial surface survey of the area in 2009 a flat piece of metal folded into a cylinder at one end was discovered on the surface at Kiflie Mado. Initial interpretation of the object was that it was a chisel bit. The circular end would have fit around a wooden haft in a similar fashion to modern hoes and other implements observed in the area. The

width of the distal end, the bit, appeared to be about the same size as the chisel marks on Gännäta Maryam Church. Unfortunately, our survey team did not have permission to remove any artifacts during surveying and it could not be recovered during subsequent research seasons. Another miscellaneous piece of metal recovered at Kiflie Mado was a long, flat piece of curved iron, possibly the tip of a knife like those still made and used today (Figure 6.23). The object was recovered by a farmer constructing stone and earth walls near our Unit 6 while we were simultaneously working in the area.



Figure 6.23. Tip of an iron knife recovered near the Kiflie Mado surface collection and excavations by a local farmer while making a bank-and-ditch for erosion control.

Slag was widely dispersed in the field where surface collection O was established and in the immediate vicinity just beyond the bounds of the field. However, extensive searching by our team and a cadre of local children failed to find any further slag on the slope above this field, which was entirely exposed bedrock and colluvial gravel. Overall, 64 pieces of slag were recovered from the surface collection, weighing 1.44 kilograms. Samples of the slag were shown to Drs. David Killick and Peter Robertshaw at a meeting in 2014 where they confirmed the slag was smithing slag rather than smelting slag. This further supports the theory of the more recent origins of the blacksmith/potter occupation

as *Ato* Gubay claimed smelting was abandoned in the region early in the 20th century when the import of scrap metal made indigenous smelting obsolete.

Much of the slag was glossy, grey, and bubbly fragments broken from larger pieces. A few round cakes of slag nearly 10 cm in diameter, however, were also recovered (Figure 6.24). Many fragments were bonded to the soil that had been beneath them, with white, glassy inclusions. A few pieces of slag were small, glassy black bubbles. Two probable ceramic tuyère fragments with black, glassy slag attached to them were also recovered, one with an internal diameter of about 5 cm (Figure 6.25). In the presence of a strong magnet, most fragments did not induce an attraction, or, at best, only a very weak one.



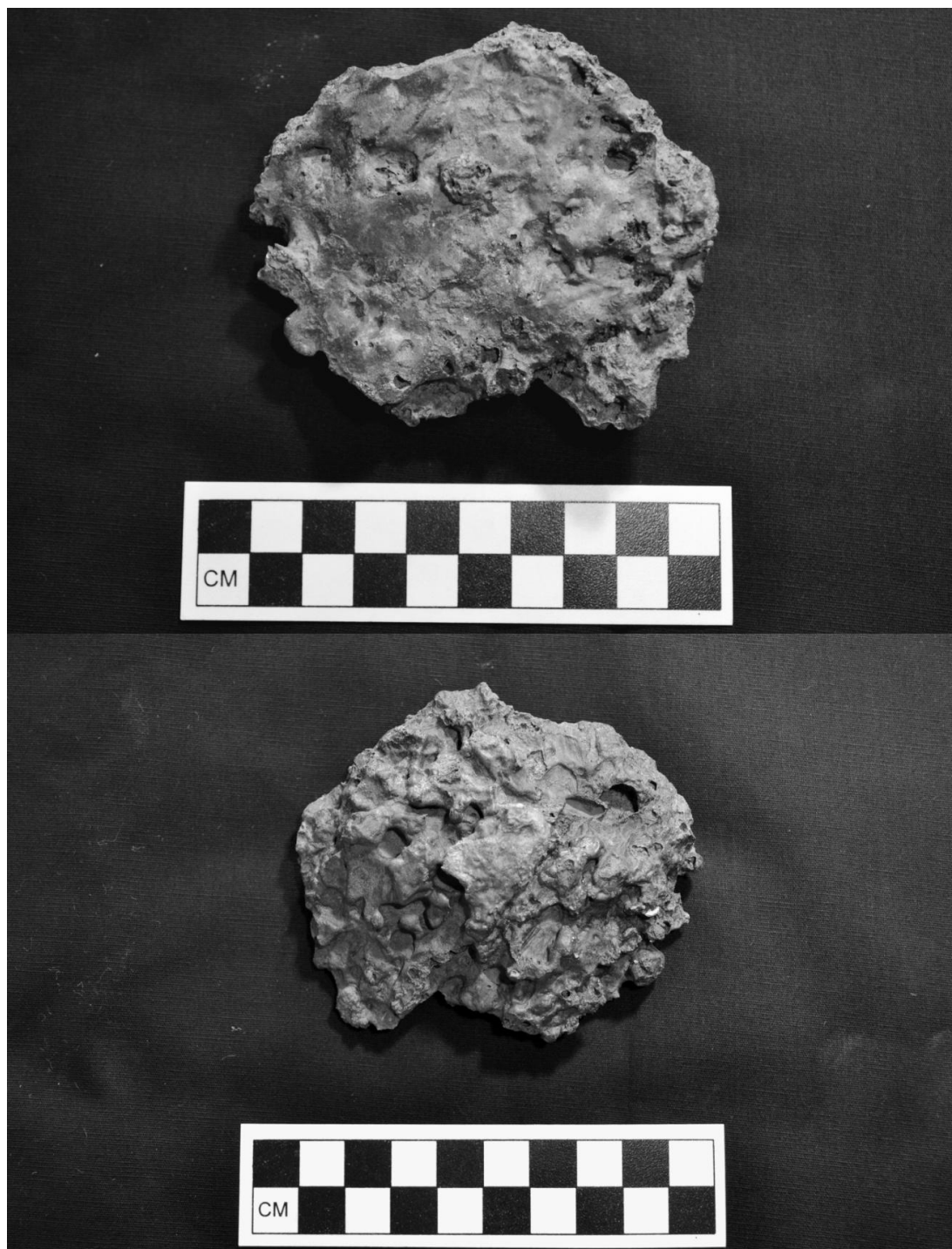


Figure 6.24. Ventral and dorsal views of a sample of smithing slag recovered from surface collection O, Kiflie Mado.



Figure 6.25. Tuyère fragment with glassy slag accreted on surface from surface collection O, Kiflie Mado.

## **Chapter 7**

### **Conclusion**

#### **7.1. Introduction**

In this dissertation, I have presented the findings of two seasons of fieldwork around the historic royal church of Gännäta Maryam. The research strongly emphasized the study of local landscape formation processes, both natural and anthropogenic, and their effects on the archaeological record there. Consequently, I have attempted to use observations of local formation processes, based on environmental research, artifact patterning, and excavation data, combined with artifact analysis, to recreate as best as possible the original archaeological landscape and its features prior to their erosion. This work provides a significant contribution to Ethiopian archaeology because such processes are likely the norm for much of the Ethiopian highlands, similarly affecting site visibility and preservation. On the one hand, this has implications for re-assessing the conclusions of previous research such as those that examine surface feature patterning and regional chronologies (e.g. Michels 2005) due to the possibilities of biased surface visibility and artifact dislocation. On the other hand, understanding the challenges archaeologists can expect and what methods may be appropriate or fruitful for certain settings will result in better-designed and more efficient research.

Here I outline the findings of research at Gännäta Maryam and add final conclusions on such topics as the origins of the study area's surface archaeological assemblages, the possible history represented by the surface archaeology and other contexts, and bias in artifact recovery and interpretation brought about by local formation processes.

## **7.2. Research at Gännäta Maryam: landscape formation processes and site formation**

Archaeological research focused on three areas surrounding the historically significant church at Gännäta Maryam, including the alluvial plain and two upland terraces in this mountainous region. Landscape archaeology provided a suitable theoretical and methodological approach for understanding the discontinuous and degraded archaeological features and contexts encountered in the study area. It offered the conceptual flexibility and geographic expansiveness to ground a thesis that examines natural and anthropogenic formation processes active at different spatial and temporal scales. Likewise, the concept of a palimpsest as utilized by theorists such as Crawford (1953) and Bailey (2007) more directly expresses the problem observed at Gännäta Maryam: like a palimpsest, successive events and practices at Gännäta Maryam have blurred the traces of earlier events, collapsing much of the archaeology into spatially and temporally undifferentiated strata or horizontal distributions. The goal of this project, then, was to identify the causes and effects of this palimpsest process and draw as much information about the muddled archaeological remains as possible.

While the concept of the Gännäta Maryam landscape-as-palimpsest provides the conceptual framework from which to launch an archaeological investigation of the study area, it requires a suitably compatible methodological approach. This approach was found in Schiffer's (1976, 1987, 1995) theories on behavioral archaeology, which concerns itself with the ways natural processes and human behaviors interact with archaeological materials and contexts to produce and modify the archaeological record from the point of creation to the present. From here, the project followed two primary courses of research into landscape formation processes: behavioral archaeology in the strict sense of human behavioral patterns, and geoarchaeology and geomorphology for making sense of the larger natural processes, often with human input, that combine to produce the archaeological landscape.

Schiffer's behavioral archaeology, while incorporating natural processes in his larger theories on formation processes, is focused more tightly on human behaviors. Principally, he emphasizes the transition from the "systemic context" of an artifact, i.e. its

use-life, to its "archaeological context," following abandonment by whatever means or occurrence. While there are many ways to attempt a reconstruction of the processes between an artifact or feature's systemic context and its archaeological context, often one of the most practical is the observation of current behaviors in search of those that produce comparable archaeological contexts. While admittedly such an approach has potential pitfalls, it has also been used successfully in the past. This ethnoarchaeological approach also has the benefit of observing how artifacts and features can move back from the archaeological context into systemic contexts once again, adding further layers of erasure and creation to the archaeological landscape.

Meanwhile, attention to geoarchaeology and geomorphology helps provide a baseline understanding of how larger landscape formation processes unfold, and what effects they can have on artifacts and archaeological contexts. This dovetails nicely with human behavioral studies because landscapes are often shaped not only by natural forces, but also by human forces. Understanding how both behavioral processes and geomorphological processes interact with one another and the canvas of the environment helps to understand how the archaeological record has come into being. Aerial photographs in particular provide an invaluable means of observing this interaction. As the effects of geomorphological and behavioral processes are often wrought on a scale larger than one can observe in a few field seasons, photographs provide a "frozen palimpsest" (Kijowska et al., 2010: 156) allowing the researchers to observe geomorphological and human effects on the landscape at different times. With a series of photographs, then, one has a time-lapsed series of copies of the palimpsest during or prior to different events of inscription or erasure.

Once in the field, I chose research methods that I thought most expediently addressed the known or assumed conditions of the local environment in a way that would address questions of human and natural landscape formation processes as outlined above. Shovel tests and excavations sought to recover archaeological features and artifacts, while also revealing the relationships between archaeological materials, topography, geomorphology, stratigraphy, and historic land use. Due to the low volume of preserved archaeological remains below the surface, extensive surface collections provided access to larger samples of historical artifacts, while illustrating their distribution and

relationships with geomorphological features like topography and pedology, and anthropogenic forces like plowing. These methods provided immediate archaeological data and revealed relationships among features of the terrain and archaeological remains in the present; however, further research was needed to put these diverse and interrelated attributes into temporal, geomorphological, and behavioral contexts.

First, my team and I surveyed the remains of an abandoned *tukul* with a known history, recounted by locals and the former occupant. In doing so, we could objectively measure formation processes like the distribution of building materials and artifacts from plowing and erosion over a known period of time from a site with a known history and identity. Second, we conducted extensive formal and informal interviews with local residents, addressing questions such as past and current land-use practices, observations of environmental change, crafting practices, and local interactions with archaeological remains. Finally, I compared the data collected with archaeological case studies on site formation processes, geomorphological research, and ethnographic research addressing similar questions to those I asked. I also examined a series of aerial photographs and satellite images of the research area interspersed over the past 50 years to compare land-use and environmental changes over time captured in the frozen palimpsests of the images with the other sources of data I had collected.

### **7.3. Results of ethnographic research, aerial imagery, and other inquiries into local formation processes**

The following provides a brief summary of the observed landscape formation processes and changes over time in the study area. The text summarizes some of the most salient details on local landscape changes and formation processes gained from locally-based research. Tables 7.1 provides additional details while 7.2-3 reiterate the more general geomorphological processes explained at length in Chapter 5.

Aerial imagery provided excellent examples of Kijowska et al.'s (2010) notion of "frozen palimpsests." As hoped, numerous changes to the landscape could be observed, and were comparable to wider trends recorded in similar historic photography research

and ethnographic research. The degree of forestation for example, though minor and certainly far less than would be natural, increased over time, particularly along drainage channels and hill slopes, perhaps due in part to official state policies in the late 1970s and early '80s. The one notable exception was the deforestation of Tarla Terrara. Gullies and other large erosion features remained relatively unchanged, while rills and smaller features diminished in extent. When viewed with the progressive return of vegetation, this may suggest that by the 1960s, the local environment had already reached a point of environmental equilibrium following a period of deforestation and consequent erosion. One notable change was the meandering of the central wadi on the lower terrace, implying that the alluvial plain is not a stable environment for archaeological preservation.

The images also show the growth of the village of Gännäta Maryam and other settlement pattern changes. During the early 1960s, the area that would become the village was farmland indistinct from its surroundings. Following the gradual introduction of government amenities and infrastructure like an improved road and school, however, the town rapidly grew. This went hand-in-hand with the depopulation of the countryside as people recounted in oral histories how they left their hamlets and isolated homesteads to live in the village, as was the case with the residents of Alem Doret. Only in the past few years does there appear to be a trend in people moving back onto their farmland, building small *tukuls*. Despite changes in settlement patterns and changes in land policies under the Derg, however, field boundaries defined by soil or stone bunds remained relatively stable.

Oral and ethnographic accounts provide further details of local life and regional changes that are not visible on the landscape, but undoubtedly play a role in shaping the contents and contexts of artifacts and assemblages. The extent of recycling and re-use of material and historic artifacts, for example, is extensive. Spent grinding stones are regularly reused for numerous purposes, as are broken ceramics and other objects. Children often use the smooth and colorful chert lithics as gaming pieces, sometimes even breaking them as observed in one instance. This recycling and reuse certainly plays a role in the distribution of archaeological material beyond original or expected areas,

contributing to the formation of the original archaeological record and its continued evolution.

Agricultural practices, meanwhile, have changed substantially in the past few generations, certainly contributing to further changes in landscape formation processes, most notably by contributing to greater rates of erosion. As Derg-era land reforms and improving social services affected rural communities, population and land pressures rose. More crops were needed to maintain subsistence and so forested areas were cleared (though some were protected and reestablished), less desirable land was cultivated, and practices like fallowing ended. Locally, cattle populations may also have declined. While informants have long recognized these processes as contributing to land degradation, they felt powerless to stop them.

Some practices, however, have remained in place, and were always somewhat damaging to long-term sustainability. Most notably, vertic soils are treated as a special class of soil that is farmed differently from others. Due largely to its ability to retain water, vertic soils are not well suited to agriculture during the rainy season unlike the area's coarser soils. Vertic soils are plowed in the dry season like other soils, but only planted at the rainy season's end. Between plowing and planting, vertic soils are exposed to heavy rains without the benefit of protective vegetation cover, resulting in extensive erosion. Before even understanding such processes, I noted to the presence of numerous rills and other signs of erosion on the vertic fields where we worked.

Today, informants and observations show a number of efforts to remediate past declines in environmental sustainability. Most notably, government-sponsored work-for-food programs employ residents to terrace and reforest hill slopes, while mandating restrictions on grazing. This is not without its own downside, however, as archaeological interests are not taken into account. We observed, for example, the disturbance of a large archaeological area on Kiflie Mado by such environmental remediation efforts, effectively obscuring the traces of archaeological remains in the area observed in previous years.



Table 7.1. Summary of landscape changes and behavioral processes in the study area as documented in oral history, ethnography, and aerial imagery.

Causes and/or means of observation	Effects and/or observations
The status quo prior to the earliest aerial images based on historic and ethnographic research	<ul style="list-style-type: none"> <li>• Landscape exploitation was extensive</li> <li>• Areas considered previously marginal were increasingly deforested and put under cultivation or intensive grazing</li> </ul>
Implementation of Selassie and Derg era land-management policies as observed in time-lapsed aerial images, oral testimony, and ethnography	<ul style="list-style-type: none"> <li>• Progressive reforestation of vulnerable areas like steep slopes and gulley margins</li> <li>• Land use intensity grew as land was re-apportioned while marginal lands were closed to development</li> <li>• As a result, agricultural land was more prone to erosion</li> <li>• Some unprotected lands like Tarla Terrara Hill were deforested to make way for agricultural land</li> </ul>
Introduction of modern amenities to the area	<ul style="list-style-type: none"> <li>• Depopulation of the agricultural land coinciding with rapid growth of Gännäta Maryam village after the mid-1960s</li> </ul>
Time-lapsed aerial images and oral testimony	<ul style="list-style-type: none"> <li>• Substantial wadi meandering in the alluvial plain</li> <li>• Stability of gullies perhaps indicating environment had already reached equilibrium prior to the mid 1960s</li> <li>• Preservation of erosion control features like field boundary bunds</li> </ul>
Oral testimony and direct observations	<ul style="list-style-type: none"> <li>• Extensive recycling and reuse of materials both from one use-context to another and of archaeological artifacts to new use contexts</li> <li>• Expectation that many artifacts will not appear <i>in situ</i> in their primary use contexts, especially grinding stones and some lithics and pottery</li> </ul>

Table 7.2. Natural and anthropogenic forces influencing erosion and their effects, as well as the influence of these processes on artifacts.

Factor relevant to geomorphological formation processes at Gännäta Maryam	Influence of said factors on landscape formation processes
Rainfall	<ul style="list-style-type: none"> <li>• The most significant factor controlling erosion</li> <li>• Rate of erosion controlled by: drop size, rain intensity and duration, characteristics of the slope and soil, and other features, many of which can be accounted for in the Universal Soil Loss Equation</li> </ul>
Deforestation	<ul style="list-style-type: none"> <li>• Removal of groundcover leaves soils prone to greater rates of erosion by influencing factors like rain infiltration, flow, and soil cohesion, among others</li> </ul>
Plowing	<ul style="list-style-type: none"> <li>• Reduces soil cohesion</li> </ul>
Agricultural practices	<ul style="list-style-type: none"> <li>• Agricultural practices on Vertisols leave them particularly prone to erosion</li> </ul>
Grazing and foot traffic	<ul style="list-style-type: none"> <li>• Grazing reduces groundcover</li> <li>• Trampling compacts soil, reducing infiltration and increasing runoff</li> </ul>
Road and path construction	<ul style="list-style-type: none"> <li>• Compacts surfaces</li> <li>• Can substantially change drainage area and runoff, leading to greater erosion or new erosion regimes</li> </ul>

### 7.3. Forces and their influence relevant to artifact movement at the surface or in plowzones

Forces affecting artifact displacement on the surface or in plowzones	Effects of forces on artifact displacement
Plowing	<ul style="list-style-type: none"> <li>• Disproportionately moves larger artifacts further than smaller</li> <li>• Smaller artifacts gradually descend, large stay at or rise to the surface</li> <li>• Greater slope increases these effects and the distance of artifact movement</li> </ul>
Slope	<ul style="list-style-type: none"> <li>• Steep slopes help sort artifacts</li> <li>• More massive objects move further down slope than less massive objects</li> </ul>
Fluvial erosion	<ul style="list-style-type: none"> <li>• More readily entrains smaller artifacts</li> <li>• Slope undercutting or retreat can remove soil and accumulate the artifacts it contained</li> </ul>

### 7.4. Formation processes and fieldwork results

The research at Gännäta Maryam supported by external research all appears to confirm suspicions that erosion and other natural and anthropogenic processes have significantly affected the preservation and presentation of archaeological materials and contexts. Areas cleared of their groundcover and/or put to agricultural uses have become far more susceptible to erosion leading to the generally poor preservation of archaeological material there. Such materials have been aggregated near the surface and scattered by processes such as plowing and fluvial entrainment. Conversely, the considerable volume of soil and other debris put into motion by erosive processes has protected some archaeological contexts, primarily where conditions allow for the deposition of the eroding material overtop of cultural deposits.

Shovel tests across archaeological and non-archaeological areas of the lower terrace showed that soil strata in most areas were quite thin, often no deeper than the plow zone itself (~15 cm). Clearing of hilltops exposed the soils there to rapid erosion as evidenced by the rills and gullies around their margins and the formation of desert pavement as the terrain seeks to reach equilibrium with its new conditions. Likewise, long-used agricultural fields display seasonal rilling and other evidence for regularly ongoing erosion. Erosion generally is to be expected on such exposed surfaces and can be predicted using USLE and other means, but is often accelerated by agricultural

practices like field preparation and secondary land-use practices. Perhaps the best example from this research is the special treatment of Vertisol soils which greatly exacerbates their susceptibility to erosion.

As a result of natural and anthropogenic processes, if there ever were archaeological deposits on or beneath sloping agricultural soils, they are gradually overturned by plowing as plowzone soil is lost, allowing the plow to progressively cut deeper into archaeological and non-archaeological soil strata. As soil erosion is likely greater than soil generation and the topography is not conducive to extensive soil recapture, there are few conceivable means archaeological deposits could be protected in such circumstances given enough time. Rather, artifacts are concentrated in the plowzone, where they are distributed by plowing, gravity, and fluvial erosion according to their topography and other factors (e.g. Table 7.3). This was readily confirmed by the analysis of surface artifact distributions.

Meanwhile, as soils erode and migrate, they pose new challenges to interpretation. Excavations on Tarla Terrara Hill, for example, demonstrated the preservation of archaeological features excavated into the bedrock; plowing and erosion of the overlying soil extending to the regolith, however, has destroyed any surrounding archaeological features that may have provided valuable context for these unique features. On the alluvial plain and its slopes, a different predicament emerged. The slopes show signs of erosion and soil mixing in the forms of gullies, rills and fans extending from the surrounding hills down to the alluvial plain. While these areas were not artifact rich in the study area, in other regions it may become difficult to distinguish material residing relatively near their original places of deposition, disturbed only by plowing for example, versus materials that may have gradually migrated due to fluvial erosion over longer courses of time. As the soils are finally deposited in the alluvial plain there is the potential that the rapid erosion and redeposition of soils from higher elevations in the catchment may have buried archaeological deposits. Indeed, shovel tests revealed very deep alluvial soils containing artifacts at all depths. However, the visibility of stratigraphy is spotty and there is a possibility that channel meandering and high-energy flow events may have scoured and mixed the soil deposits, effectively erasing any

preserved contexts while mixing materials from different times and contexts found within the catchment.

Where archaeological contexts do preserve well is where they are at the receiving (depositional) end of the study area's severe erosion regime. Natural buttresses and the changes in topography at the bases of steep slopes provide ideal circumstances for recapturing eroding soil within the catchment. Thus, the house floor excavated at Kiflie Mado was well-preserved under finely sorted alluvial and/or colluvial strata thanks to its location between a steep, cultivated slope and the remnant of a house or compound wall. The areas immediately behind the region's earth and stone bunds have the potential to similarly preserve archaeological contexts. While such features were not studied intensively, the deep deposit of distinct soil strata and artifacts behind the bund on the saddle between the village and Tabot Madera, where the rest of the saddle was clearly eroding down to the regolith attests to this possibility. Likewise, the church cemetery covering the slope ascending to the church shows how erosion and redeposition can endanger the elevated area of the cemetery, while entirely encapsulating burial mounds at the slope's base.

With all these disturbed contexts and processes at play, it was difficult to discern meaningful patterns among the artifact assemblages. Mapping and surveying of the recently abandoned *tukul* helped to document the degradation and dispersal of artifacts and archaeological contexts in a plowzone setting over a known length of time. The artifacts we recovered there and their dispersal helped confirm the relatively short time required for such homes to come to resemble artifact distributions elsewhere. Furthermore, the similarity in artifacts at the site supports the conclusion that many other plowzone artifact distributions are likely from agrarian occupational sites and quotidian activities. The greater relative density of lithics at the *tukul* site compared to other surface assemblages when viewed in light of data on plowzone distribution and aggradation of artifacts, however, suggests that the dearth of lithics elsewhere is probably due to plowzone processes rather than original scarcity during any surveyed area's occupation. Ceramics meanwhile show little overall change from the recent *tukul* site through to the oldest dated features. Stylistically, ceramics remain fairly similar across all contexts. The only significant differences observable in the greatly fragmented and

aggraded assemblage are changes in manufacturing due to recent changes in access to resources and perhaps a change in decorative preference from sgraffito to incising. The majority of ceramics likely served commonplace domestic functions, though ceramic artifacts were often too fragmented to discern more specific vessel forms or functions. In plowzone contexts, faunal remains are rare and likely insignificant to archaeologists, though they preserve well in intact features. However, with only a few intact features of uncertain function or origins containing faunal remains (the pit features at Tarla Terrara and the ash heap at Kiflie Mado), there is little to be interpreted from these assemblages alone. Both contain a mix of domestic and wild animals, the latter covering a wide range of small avians, mammals, and reptiles. Metal artifacts were recovered in a few preserved contexts, though most metal artifacts and all slag were found at the reputed iron working site at Kiflie Mado and are thought to date to the early 20th century.

## **7.5. Conclusion: The chronological evolution of Gännäta Maryam**

Summarizing the evidence presented throughout this thesis, the following presents a hypothetical reconstruction of the history of the research area, including the production, and erasure of its archaeological features. With the heavily degraded nature of the archaeological contexts found in the study area, such a reconstruction is conjectural and broad without further evidence, possibly from fields like sedimentology and palynology. However, based on the evidence available for this thesis, it does provide a succinct conclusion to this study.

### **7.5. (a) The 17th century**

The earliest dated archaeological material at Gännäta Maryam comes from pit features in units 4 and 5 at Tarla Terrara Hill. The charcoal sample from within Unit 4 and from the interface of strata within Unit 5 both provided similar radiocarbon profiles, with a good likelihood of a 17th-century origin. While this does not date the features or

contents directly, the similarity in dates supports the occurrence of contemporary events leading eventually to the pits' infilling. Though the pits themselves may have been cut previous to the charcoal samples, the radiocarbon dates suggest the events leading up to their infilling were probably roughly contemporary to one another. Ceramics recovered from these and other contexts at Gännäta Maryam all tentatively support this as the earliest terminus for the good preservation of archaeological material. Archaeological sites in northern Ethiopia from the Late Aksumite Period to the 17th century (effectively the latest archaeological contexts reported in detail by archaeologists) across northern Ethiopia frequently contain ceramics with cruciform designs and sometimes Ge'ez characters (e.g. Wilding and Munro-Hay 1989: 297; Phillips 2000: 327, Figure 282; Taferre 2010: 85; Chuniaud 2012: 273, Figure 9.12.6, 278, Figure 9.16.1; Tesfaye, n.d.: Figures 9-13). While numerous decorated sherds were recovered from Gännäta Maryam, including Units 4 and 5, no sherds had these characteristic motifs. With so little research on Ethiopian ceramic typologies and chronologies, particularly beyond the 17th century, the absence of these motif is not proof of a post-17th century date, but when combined with the radiocarbon dates, it is highly suggestive.

Doubtless, human occupation of the area extends further back, particularly since accepted dates for Gännäta Maryam church are much older (Phillipson 2009: 116). The dates of these features then may suggest an approximate limit beyond which aggradational forces in the region are likely to have erased or so thoroughly disturbed archaeological contexts and remains that only in circumstances of exceptional scale and/or durability are they likely to have survived into the present. Indeed, except for large-scale stone architecture, there are not likely to be more durable archaeological contexts in Ethiopia than those cut into bedrock (however, see discussion below).

These features and this time period then are a good point from which to begin piecing together the evidence for human and environmental landscape processes and transformations at Gännäta Maryam. Returning to Darbyshire et al.'s (2003) environmental reconstruction of the highlands, the 17th century coincided with the ending of the expansion of the *Juniperus* dominated Afromontane forest complex. Like 20th century observations of forest regrowth (Woien 1995a-b; Crummey 1998), however, this return may have been spotty and localized (Derbyshire et al. 2003: 544). After 1700,

the forest complex gives way rapidly to the grass and scrub dominated landscape observed throughout the 20th century, excluding the results of introduced eucalyptus farming and government sponsored environmental remediation efforts.

At Gännäta Maryam, then, we may assume that in the 17th and perhaps early 18th centuries, occupation of the region followed the pattern normally believed by residents and ethnographers (e.g. Dejene, 1990) to have been the norm. Hilltops like Tarla Terrara and Alem Doret, and slopes like those dividing the terrace peds would have been at least moderately forested while the fertile soils of the alluvial plain and deeper soils of the upper terraces would have been under bimodal cultivation, probably with periodic field rotation and fallowing. Field boundaries, particularly the durable earth and stone bunds, probably reflected many historic divisions still visible today. Undoubtedly animal herds would have grazed the hills, slopes and other communal pasturage during the growing seasons and foraged on the stubble of cultivated fields during the dry season. Possibly, herds and grazing pressure were small enough that their impact on hill and slope vegetation would not have pushed it over the sustainability thresholds described by Mwendera and Saleem (1997).

Human occupation of the area probably followed the pattern observed in aerial imagery prior to the introduction of modern amenities and as reported ethnographically by Dejene (1990). Small hamlets of loosely clustered *tukul* and *nas* houses would have dotted the rocky prominences of the peninsulas of Tabot Madera and the margins of slopes much as they do today. Elsewhere, single homes would have been dispersed across otherwise open fields. While no clear evidence links the features on Tarla Terrara to a domestic settlement, the presence of utilitarian ceramics on the hill and in the features equitable to those collected elsewhere in the study area supports the possibility. As the former resident of the Alem Doret *tukul*, Setegen, explained (see also Dejene 1990: 23), such hills when forested are often considered reasonable places for a dwelling. Housing there does not occupy otherwise cultivable land and the forest coverage provides some shelter from winds, sun, and rain.

The village of Gännäta Maryam was generations away from emerging, though under the feudal system, the royal church of Gännäta Maryam may have hosted a much larger and more organized religious community. Where is uncertain, though quite likely

it was where it remains today, just to the north and west of the church on the elevated ground and terrace there. While amenities have attracted people to modern Gännäta Maryam village, in the past, church *gult* rights to locally produced resources and labor would have made the area at least a minor focus of the local economy and social life. It is not out of the question that a regular market may even have been held in the area, as one is today.

Though gullies probably made up a large portion of the local drainage network, they were probably the largely inactive and partially effaced gullies described by Frankl et al. (2011), having formed under previous environmental and climactic conditions (see also Nyssen et al. 2006). These features together may also have reduced the effects of heavy seasonal rains on the alluvial plain. With more groundcover reducing the rate of output of water to the central wadi - assuming little change in rainfall over the past few centuries - the wadi would have received less water thus flowing with less energy and possibly flooding less frequently. In an adequate low-energy state, it would have been prone to meander more extensively, consequently removing any archaeological contexts in its path. Slopes like those at Kiflie Mado may also have had deeper and more extensive coverings of soil retained by a greater vegetation cover. Such slopes were not necessarily inhabited at this time though, assuming population pressure was still insufficient to push people to marginal lands.

Agricultural land and other areas, meanwhile, may not have been so different in the past. While periodic fallowing and containment of agriculture to only optimally suited fields (e.g. no farming on leptic soils and steep slopes) was probably more widely practiced, this would not necessarily have meant less erosion on those lands than on today's; assuming little change in agricultural practices, use of soils like Vertisols would still have left them prone to extensive rill and gulley erosion. Similarly, the effects of trampling and plowing on erosion, and plowing on the dislocation of soils and artifacts, on other fields would not likely have changed substantially. Even in low-angled fields, soil would likely continue to wash from the higher end of the field and collect behind lower bunds. Rills or incipient gullies like those observed in the early aerial images would probably have been present. The best effect fallowing may have had was to maintain soil fertility and organic content to a slightly greater degree, increasing soil



cohesion in subsequent years. Periodic fallowing would also reduce net soil loss or dislocation over large lengths of time, simply by punctuating the normal rate of soil loss due to agricultural practices by a temporary cessation of these processes for a few seasons.

During this period, the potential for archaeological preservation would have been at its greatest in some contexts, though little different in others. Rates of slope creep and slope wash on hillsides and terrace slopes would have been checked by woody, mature perennial vegetation. Hilltops like Tarla Terrara and Alem Doret probably had at least thin O and A soil strata rather than today's erosion pavements, providing some protection to surface features and deposits, perhaps even burying some deposits with sufficient time. Preservation would have been immeasurably better than today simply by the absence of plowing of these areas.

Potential archaeological features elsewhere, however, may not have fared significantly different than today. Dispersed houses placed on cultivable soils across Tabot Madera and the upper terraces, for example, would still be subject to periodic abandonment, recycling of materials like stone foundations, and the plowing of any *in situ* remains from the homestead back into the plowzone. With greater groundcover stabilizing slopes rather than today's plowed surfaces, there would be no rapid accumulation of colluvium near the bases of such slopes. Homes like that on Kiflie Mado would remain exposed to the environment far longer than they would when the slopes were denuded, and so might risk greater deterioration. However, remains that survived might be more visible to modern surveyors. Plowed fields hemmed by rock and earth bunds would still erode to a more level position. Though this may continue to preserve *in situ* strata immediately behind the bund, material from the upper portion of the field would be eroded behind the bund as well. This transported material would be mixed and possibly cause a reverse stratigraphic relationship between *in situ* and transported materials behind the bund.

### 7.5. (b) 1700s to c. 1974

Beginning around 1700, Darbyshire et al. (2003) report a rapid deforestation of the highlands bringing the landscape up to the conditions in which it was observed in the 1900s. The effects of such deforestation had a watershed effect on the environment and local archaeology, likely producing much of the archaeological patterning observed in the area today. Though reasons for a changing environment in this period have not been systematically evaluated, some probable causes might include the migration and assimilation of Oromo pastoralists north of the Awash through the 17th and 18th centuries and the political and social instability that characterized the "Era of the Princes" (late 18th to mid 19th centuries) and the following period of unification and modernization leading into the 20th century.

At first, the daily life of Gännäta Maryam residents probably continued on as it had previously. There is no indication that settlement patterns changed during this period. Probably, residents continued to settle in small hamlets and areas centrally located near their fields. The re-emergence of *tukuls* observed during fieldwork on or near older surface scatters of artifacts on plowed fields, like those near surface collections N and D, may suggest that such areas have always possessed attributes that have attracted residential occupation. Continued occupation, followed then by abandonment, recycling of materials, plowing, and reoccupation of these sites throughout the past few centuries has likely produced much of the current dispersal of surface materials seen across plowed areas of Gännäta Maryam today, particularly in the older agricultural areas like Tabot Madera and Agay Midir.

It was probably during this period that serious environmental imbalances began to emerge as pressure mounted on available agricultural land and pasturage, reaching its peak in the early to mid 20th century. With exceptionally large livestock herds reported in Wollo during the 20th century, livestock may have come into competition with farming for grazing land throughout the year (Dejene 1990: 22-24). People at Gännäta Maryam, requiring more land, probably began to push into previously marginal areas. Farmland would have extended up slopes considered less-than-ideal for farming, replacing native perennial vegetation. This would have reduced the land area of wooded

slopes normally left for rainy-season livestock herding. With less land available to them, grazing pressure by livestock on slopes would have increased, resulting in overgrazing and the beginnings of increasing soil loss.

As populations continued to increase through the 20th century, this cycle would have worsened. Agricultural fields continued to expand up slopes formerly left vegetated for grazing. Meanwhile, the reduced availability of wooded slopes would have increased grazing pressure on those areas that remained, as well as reducing the availability of wood for human use. With fewer woody resources available, people turned to animal dung for fuel whereas it had previously been used as manure (Dejene 1990: 29-30). The reduction in manuring resulted in less fertile lands at a time of greater need. Reduced crop yields would have further intensified demands for marginal land and reduced the rate of fallowing. The results of these feedbacks would have been the gradual clearance of wooded slopes. Whereas these slopes were probably in a state of static equilibrium with their environment under low to moderate exploitation, under extensive clearance and heavy exploitation, they would have been thrown into an unstable system where rain, trampling and plowing would all have led to intense erosion by sheetwash, rilling, and gully formation. On previously favored cultivated areas, meanwhile, the reduction in manure fertilization and fallowing would have reduced the organic content of the soil, thus reducing soil cohesion, facilitating easier detachment and transport during episodes of intense rain.

According to Frankl et al. (2011), it would have been during this period that gullies would have again become active, or formed anew. Without a protective groundcover and practices meant to maintain soil quality, both steeply sloping areas and previously cultivated areas would have begun to undergo the massive and unsustainable rates of erosion that the Ethiopian government and NGOs have been attempting to remediate since the 1970s. The impact on the appearance of the local landscape and archaeology would have been dramatic.

It was probably during this period that areas like Tarla Ferrara and many areas of Tabot Madera, particularly to the west, were largely reduced to thin leptic strata over regolith, with the erosion channels and alluvial fans descending the low hill slopes emerging and remaining up to the present. Following Nyssen et al.'s (1997) findings on

soil recapture in catchments, however, it is likely much of the soil eroded from elsewhere in the region was redeposited in the alluvial plain. This, for example, would explain the thick layer of vertic soil on the western fields of the Tabot Madera floodplain. Under less intensive and more sustainable agricultural practices, the vertic fields along the north of Tabot Madera may have been at least slightly more stable than they are today while the wadi would have received less soil from the surrounding catchment. As the volume of soil transported into the catchment increased, this may have initiated Billi's (2009) hyperconcentrated flow events, if that is indeed what is happening. Flooding over the wadi banks would then have deposited much of the transported alluvium, including a large portion of vertic clay, over the western side of the flood plain, thus explaining the presence of the thick vertic layer over the finer strata of clay-poor alluvial strata.

Many of the archaeological features seen at Gännäta Maryam probably also first originated in this period. The artifact scatters across Agay Midir and Tabot Madera probably all have their origins in small homesteads established through this period. As the Alem Doret *tukul* survey showed, a *tukul* can be occupied for less than twenty years, abandoned, plowed back into the soil, and produce an artifact pattern similar to those observed across Tabot Madera and Agay Midir within a few decades or less. Differences in artifact patterns like the paucity of lithics is likely a result of post-depositional processes like plowing reducing the surface visibility of such artifact classes. With more time, even the rocks that once formed the *tukul* foundation will likely have been moved by the current farmer or distributed back into the plow zone. The similarity in ceramic types and rim profiles across all surface collections in the area further support the claim that they all derive from similar occupations during the same period of time. Artifact classes and types also coincide with those initially expected during the project proposal phase of this research (Table 4.1), albeit far fewer artifact classes than predicted were recovered, likely due to artifact recycling behaviors only understood after ethnographic research and turbation processes were studied after fieldwork was completed.

As previously discussed, the Kiflie Mado blacksmith-potter occupation probably also occurred during this period, early in the 20th century. With a denuded and over-exploited hillside, erosion accelerated, eventually burying the site under colluvium and stripping the remainder of the slope above it of virtually all soil and artifacts. It is

likewise quite possible a number of other archaeological contexts have been buried at the bases of slopes due to the accelerated rate of erosion in this period.

Finally, this was probably also the time in which erosion pavements would have formed over relatively level areas like Tarla Terrara and parts of Alem Doret, though Tarla Terrara was admittedly cleared and plowed exceptionally late, technically putting it in the next regional phase. Hilltop clearance and plowing likely disturbed a significant amount of archaeological material in these areas during this period, both through mechanical erasure of features and movement of artifacts and through the erosion of the exposed, unconsolidated soils. Counterintuitively, however, the formation of the erosion pavement after plowing ceased may help preserve remaining artifacts and contexts like the remaining wall foundation discovered in Alem Doret, Unit 1. While this pavement forms through the removal of soil and thus the deflation of artifacts onto the surface, this concentration of compacted large-fraction material helps reduce further erosion. In such settings then, archaeologists may encounter a period of rapid erosion shortly after exposure, followed by a period of relative stasis as the erosion pavement consolidates and provides some protection to subsurface remains similar to the protection afforded by vegetation. However, the formation of such pavements creates their own problems, on the hilltops particularly, and their presence may only slow an inevitable process. By reducing infiltration on the hilltops, runoff over the hillsides will be greater. This is already exposing bedrock and regolith on both hills at Gännäta Maryam, which will only further concentrate overland flow into rills and gullies over the hillsides, eventually cutting back the hill tops and endangering contexts around the margins before progressively causing more severe erosion inward over the hill's shrinking upper surface.

## **7.5. (c) 1974 to present**

The final period coincides with the land reforms first imposed by the Derg up to the present time of fieldwork at Gännäta Maryam. This period has been characterized by strong efforts to ameliorate the environmental damage done in the past. While this is good for residents and future generations of Ethiopians, such efforts are actually

endangering local archaeology even further. Meanwhile, efforts to "modernize" the country have had a number of effects on the local population and settlement patterns.

The reforms of the Derg and present Ethiopian government have taken a strong stance on environmental improvement and protection. This appears to be slowly reversing the trend of rapid environmental degradation seen in the past, but is having little notable impact on local archaeology for the better. Arguably, much of the damage to local archaeology that could be done, already has occurred. Hillside exclosures, reforestation, and better resource management are all good for the environment and may prevent some of the processes that affected archaeological features in the past from happening to new contexts going in to the future, but if anything, such projects are probably insufficient to further protecting already affected archaeological contexts and may be further endangering others.

As previously described, environmental remediation efforts at Gännäta Maryam have mostly involved exclosure of the steep terrace slopes, the construction of stone lynchets there, and tree planting in microbasins behind the lynchets. For the majority of archaeological contexts at Gännäta Maryam, these efforts are unlikely to have a substantial positive effect. Archaeological contexts created on or subsequently subsumed by plowing will have already undergone irreversible disturbance. Marginal lands like the hilltops of Alem Doret and Tarla Terrara are also not subject to these efforts. For one reason or another, such areas remain under private ownership and are still required by locals for basic necessities. *Ato* Dejene has ceased cultivation of Tarla Terrara, but only because the land is currently more valuable to him for cultivation of *Acacia* and grasses for fuel wood and fodder. Alem Doret, meanwhile, has been denuded and under cultivation for over fifty years and is unlikely to be reforested. While slope protection may mean less alluvium washing onto the floodplain, this is likely to have little effect on extant local archaeology. At the bases of slopes where soil has already inundated contexts like the Kiflie Mado home, reforestation may help to keep such contexts buried longer, but will not likely have any further effect besides stem the flow of additional colluvium if the slope above the site were not already exposed rock.

What these projects are doing, however, is potentially disturbing as yet unexplored archaeological contexts. While working at Kiflie Mado, for example, the

farmer digging soil to build his terrace wall was haphazardly disturbing a number of large pottery fragments, many better preserved than those found in the contexts we excavated. A similar bank and ditch bund had already bisected the ash flow partially excavated by Unit 6. Just to the west of the Kiflie Mado study area the slope has not only undergone extensive bund and lynchets construction, but also regularly spaced tree planting in micro-basins. All these activities have overturned and moved significant amounts of soil and will create a topography sure to move more as the ground surface behind each bund or lynchets declines to a more level plain. Previously, during initial surveying in 2009, a much wider spread of iron slag and pottery than that studied here had been identified in this area. However, the recent enclosure and slope modifications have resulted in a completely overturned and reconstructed environment in which little if any sign of the originally extensive dispersal of slag and pottery could be identified. Almost surely any feature of reasonable size not deeply buried has also experienced some disturbance, or will as the ground behind the lynchets settles and tree roots again take hold on the slope.

Also related to the local archaeology are all the social changes that have occurred following attempts to modernize the region. The introduction of amenities like a road, school, clinic, and electricity has significantly altered the logic of local settlement patterns. Whereas previously people preferred to live spaced apart from one another and nearer to the center of their land holdings, many people now are strongly attracted to the benefits of living in the village. Thus, while a researcher may once have observed homesteads located in fields near older artifact scatters like those on Tabot Madera, making the connection between the two, today, the settlement pattern is so significantly altered one cannot assume that modern habitation areas necessarily reflect traditional patterns.

Land redistribution and other social changes have also had an effect on artifact production. Land redistribution and the dismantling of the feudal order, for example, divorced some residents like Tsehaynesh from her original sources of crafting materials causing a notable change in the paste and quality of local pottery. Presumably, other crafting specialists experienced similar alienation from necessary resources causing significant changes to craft production techniques and products, granting such products important temporal attributes.

## 7.6. Discussion

In summary, the potential for substantive archaeological preservation at Gännäta Maryam is quite low, and by extension, one may expect that similar conditions influence archaeological site preservation and appearance elsewhere. Erosion in the highlands under past and present land-use patterns and practices has been too severe to preserve most archaeological contexts. While working in such settings, the only places researchers might readily expect good archaeological preservation are areas where geomorphological conditions are suited to soil deposition and/or transport limited denudation. Such areas are most likely to be at the bases of steep slopes and behind impediments to further soil movement like walls and bunds. In addition, stands of vegetation may also serve similar functions, though no such features were identified or studied in this research project.

The caveat that must be made to the above claim is that we currently cannot know what types of archaeological features have been lost in the study area. As it stands, it appears all substantive archaeological traces older than about 300 years have been irretrievably dispersed into background noise, and those that have persisted are the residues of mundane, agrarian life. However, while most archaeological features in the highlands beside monumental architectural elements are likely to be ephemeral, the absence of preserved remains at Gännäta Maryam does not preclude that additional exceptional site-types or features have not preserved in other settings, perhaps under conditions not found in the study area. As such, this research should help archaeologists evaluate the archaeological viability of different terrains elsewhere in the terraced mountain highlands, but should not preclude exploratory *sondage* in areas deemed less amenable to archaeological preservation.

Regarding future research methods, this research suggests that typical forms of archaeological reconnaissance are not likely to be fruitful, and may be misleading. Surface artifacts on study area plowzone soils, for example, were not indicative of subsurface features as might commonly be expected. Meanwhile, intact features often had few traces on the surface. Furthermore, artifact displacement could be quite extensive in some instances. Thus, surface surveying for "site" identification is likely an



inadequate means of archaeological reconnaissance, except perhaps at regional scales where the questions are oriented more toward topics like identifying the presence of diagnostic artifacts across landscapes. That being said, however, surveyors must also take into account the sites and features they are not seeing that have been covered by displaced soils. Research methods more appropriate to regions like Gännäta Maryam might include shovel testing and test excavations of deep soil deposits in areas where soils have accumulated over time or where they are protected against erosion. As a side note, these warnings may also sound the need to use previous regional survey results with caution.

## Bibliography

Abir, Mordechai

- 1980 *Ethiopia and the Red Sea: The Rise and Decline of the Solomonian Dynasty and Muslim-European Rivalry in the Region*. London: Frank Cass and Company, Ltd.

Ahmad, N.

- 1996 Occurrence and distribution of Vertisols. In *Vertisols and Technologies for their Management*. N. Ahmad and A. Mermut, eds. Pp. 1-42. Amsterdam: Elsevier.

Ahmad, N. and A. Mermut, eds.

- 1996 *Vertisols and Technologies for their Management*. Amsterdam: Elsevier.

Ahnert, Frank

- 1998 *Introduction to Geomorphology*. London: Arnold.

Allen, M. J.

- 1991 Analysing the landscape: a geographical approach to archaeological problems. In *Interpreting Artifact Scatters: Contributions to Ploughzone Archaeology*. A. J. Schofield, ed. Pp. 39-58. Oxford: Oxbow Books.

Ammerman, Albert J.

- 1985 Plow-Zone Experiments in Calabria, Italy. *Journal of Field Archaeology*, 12: 33-40.

Angelini, Anacleto

- 1967 Le chiese monolitiche di Lalibela. *Atti dell'Ateneo di scienze, lettere ed arti in Bergamo*, 33: 3-24.

Antevs, Ernst

- 1935 The occurrence of flints and extinct animals in pluvial deposits near Clovis, New Mexico. Part 2: Age of Clovis lake beds. In *Proceedings of the Philadelphia Academy of Natural Science*, 87: 304-311.

Arndt, Nicholas

- 2005 The Ethiopian Large Igneous Province. *LIP of the Month*, January. Large Igneous Provinces Commission, International Association of Volcanology and Chemistry of the Earth's Interior. <http://www.largeigneousprovinces.org/05jan>. Accessed: 7 October 2014.

Arthur, John W.

- 2002 Pottery use-alteration as an indicator of socioeconomic status: an ethnoarchaeological study of the Gamo of Ethiopia. *Journal of Archaeological Method and Theory*, 9(4): 331-335.

Astatke, Abiye, M.A. Mohamed Saleem, Mohammad Jabbar, and Teklu Erkossa

- 2002 Development and testing of low-cost animal drawn minimum tillage implements: Experience on Vertisols in Ethiopia. *Agricultural Mechanization in Asia, Africa, and Latin America*, 33(2): 9-14.

Baker, Charles

- 1978 The size effect: An explanation of variability in surface artifacts assemblage content. *American Antiquity*, 43(2): 288-293.

Bailey, Geoff

- 2007 Time perspectives, palimpsests and the archaeology of time. *Journal of Anthropological Archaeology*, 26: 198-223.

Balicka-Witakowska, Ewa

- 1998-9 Les peintures Murales de l'église rupestre Éthiopienne Gannata Maryam près Lalibela. *Arte Medievale*, 12/13: 193-202.
- 2007 The wall-paintings in the sanctuary of the church of Gannata Maryam near Lalibela. In *Ethiopian Art - A Unique Cultural Heritage and Modern Challenge*. W. Raunig and Asfa-Wossen Assef, eds. Pp. 119-37. Lublin: Bibliotheca Nubica et Aethiopica no. 10.

Balicka-Witakowska, Ewa, and Michael Gervers

- 2001 The church of Yemrehena Krestos and its wall-paintings: a preliminary report. *Africana Bulletin*, 49: 9-47.

Barber, R.

- 1984 *An assessment of the domination soil degradation processes in the Ethiopian highlands*. Ethiopian Highlands Reclamation Study. Addis Ababa: unpublished.

Bard, Kathryn, A.

- 1997 Introduction. *The Environmental History and Human Ecology of Northern Ethiopia in the Late Holocene*. Studi Africanistici. Sterie Ethiopica, 5. Naples: Istituto Universitario Orientale.

Bard, Kathryn A., ed.

- 1997 *The Environmental History and Human Ecology of Northern Ethiopia in the Late Holocene*. Studi Africanistici. Sterie Ethiopica, 5. Naples: Istituto Universitario Orientale.

Bard, Kathryn A., Mauro Coltorti, Michael C. DiBlasi, Francesco Dramis, and Rodolfo Fattovich

- 2000 The environmental history of Tigray (Northern Ethiopia) in the Middle to Late Holocene: A preliminary outline. *African Archaeology Review*, 17(2): 65-86.

Bartnicki, Andrzej and Joanna Mantel-Nieko

- 1969-70 The Role and Significance of the religious conflicts and people's movements in the political life of Ethiopia in the seventeenth and eighteenth centuries. *Rassegna di studi Etiopia*, 24: 5-39.

Beckingham, C.F. and G.W.B. Huntingford, eds.

- 1961 *The Prester John of the Indies: A True Relation of the Lands of the Prester John*. Francisco Alvares, auth. Lord Stanley of Alderly, trans. Cambridge: Cambridge University Press.

Berakhi, Ogbaghebriel, and Ludovico Brancaccio

- 1993 Some reflections on the origin and land use of pediments on Ethiopian highlands. *Geografia Fisica e Dinamica Quaternaria*, 16: 101-106.

Berakhi, Ogbaghebriel, Ludovico Brancaccio, G. Calderoni, M. Coltorti, F. Dramis, and Mohammed M. Umer

- 1998 The Mai Maikden sedimentary sequence: A reference point for the environmental evolution of the Highlands of Northern Ethiopia. *Geomorphology*, 23: 127-138.

Bettis, E. Arthur and Rolfe D. Mandel

- 2002 The effects of temporal and spatial patterns of Holocene erosion and alluviation on the archaeological record of the central and eastern Great Plains, USA. *Geoarchaeology*, 17(2): 141-154.

Bewley, Robert H.

2003 Aerial survey for archaeology. *The Photogrammetric Record*, 18(104): 273-292.

Bianchi Barriviera, L.

1963 *Le chiese in roccia di Lalibela e di altri luoghi del Lasta*. Rome: Istituto per L'Oriente.

Bidder, Irmgard

1959 *Lalibela*. trans. Rita Grabham-Hortman. New York: Frederick A. Praeger, Inc.

Billi, Paolo

2008 Bedform and sediment transport processes in the ephemeral streams of Kobo basin, Northern Ethiopia. *Catena*, 75: 5-17.

Binford, Lewis

1978 *Nunamiut Ethnoarchaeology*. New York: Academic Press.

Binford, Lewis, Sally Binford, Robert Whallon, and Margaret Ann Hardin

1970 Archaeology at Hatchery West. *Memoirs of the Society for American Archaeology*, 24: 1-91

Le Bissonnais, Yves and Michael J. Singer

1992 Crusting, runoff, and erosion response to soil water content and successive rainfalls. *Soil Science Society of America*, 56(6): 1898-1903.

Blackburn, W. H.

1975 Factors influencing infiltration and sediment production of semiarid rangelands in Nevada. *Water Resources Research*, 11: 929-937.

Boismier, W. A.

1991 The role of research design in surface collection: an example from Broom Hill, Braishfield, Hampshire. In *Interpreting Artifact Scatters: Contributions to Ploughzone Archaeology*. A. J. Schofield, ed. Pp. 11-29. Oxford: Oxbow Books.

Bosc- Tiessé, Claire, Marie-Laure Derat

- 2011 Acts of writing and authority in Bəgwəna-Lasta between the fifteenth century and the eighteenth century: A regional administration comes to light. *Northeast African Studies*, 11(2): 85-110.

Bosc- Tiessé, Claire, Marie-Laure Derat, Laurent Bruxelles, François-Xavier Fauvelle-Aymar, Y. Gleize, and R. Mensan

- 2014 The Lalibela rock hewn site and its landscape (Ethiopia): An archaeological analysis. *Journal of African Archaeology*, 12(2): 141-164.

Bouwer, H.

- 1986 Intake rate: cylinder infiltrometer. In *Method of Soil Analysis, Part 1*. Agronomy Monograph No. 9, 2nd Edition. A. Klute, ed. Pp. 825–44. Madison, WI: American Society of Agronomy and Soil Science Society of America

Brandt, Steven and Kathryn Weedman, directors

- 2006 *Woman the Toolmaker: Hideworking and Stone Tool Use in Konso, Ethiopia*. 25 mins. Walnut Creek, CA: Left Coast Press.

Brooks, Alasdair

- 2008 Ploughzone archaeology in historical archaeology. In *Handbook of Landscape Archaeology*. Bruno David and Julian Thomas, eds. Pp. 596-600. Walnut Creek, CA: Left Coast Press.

Bryan, Kirk, and Louis L. Ray

- 1940 *Geological Antiquity of the Lindenmeier Sites in Colorado*. Smithsonian Miscellaneous Collections, vol. 99, no. 2. Washington DC, Smithsonian Institute.

Busby, F. E. and G. F. Gifford

- 1981 Effects of livestock grazing on infiltration and erosion rates measured on chained and unchained pinyon-juniper sites in Southern Utah. *Journal of Range Management* 34: 400–5.

Butzer, Karl W.

- 1977 Environment, culture, and human evolution. *American Scientist*, 65(5): 572-584.  
 1981 Rise and fall of Aksum, Ethiopia: A geo-archaeological interpretation. *American Antiquity*, 46(3): 471-495.  
 1982 *Archaeology as Human Ecology*. Cambridge, UK: Cambridge University Press.

Butzer, Karl and Carl Hansen

1968 *Geomorphology and Prehistoric Environments at the Aswan Reservoir*. Madison, WI: University of Wisconsin Press.

Buxton, D.R.

1947 The Christian Antiquities of Northern Ethiopia. *Archaeologia*, 92: 1-42.

Cahen, D. and J. Moeyersons

1977 Subsurface movements of stone artefacts and their implications for the prehistory of Central Africa. *Nature*, 266: 812-815.

Cardelus, Catherine L., Peter Scull, Joshua Hair, Maria Baimus-George, Margaret D. Lowman, and Alemaheyu Wassie Eshete

2013 A preliminary assessment of Ethiopian sacred grove status at the landscape and ecosystem scale. *Diversity*, 5: 320-334.

Cheung, Wing, Gabriel Senay, and Ashbindu Singh

2008 Trends and spatial distribution of annual and seasonal rainfall in Ethiopia. *International Journal of Climatology*, 28: 1723-1734.

Chojnacki, Stanislaw

1963 Forests and the forestry problem as seen by some travellers in Ethiopia. *Journal of Ethiopian Studies*, 1(1): 32-39.

Chuniaud, Kristell

2012 Études des céramiques des fouilles du manz. In <<Gabriel, une église médiévale d'Éthiopie>>. *Annales d'Éthiopie*, hors-series #2. Marie-Laure Derat and Anne-Marie Jouquand, eds. Pp. 249-292. Addis Ababa, Ethiopia: De Boccard / Centre Français des Études Éthiopiennes.

Ciampalini, Rossano, Paolo Billi, Giovanni Ferrari, Lorenzo Borselli, Stephane Follain

2012 Soil erosion induced by land use changes as determined by plough marks and field evidence in the Aksum area (Ethiopia). *Agriculture, Ecosystems and Environment*, 146: 197-208.

Clark, R. H. and A. J. Shofield

- 1991 By experiment and calibration: an integrated approach to archaeology of the ploughsoil. In *Interpreting Artifact Scatters: Contributions to Ploughzone Archaeology*. A. J. Schofield, ed. Pp. 93-106. Oxford: Oxbow Books.

Clarke, D. L.

- 1968 *Analytical Archaeology*. London: Methuen and Company, Ltd.

Climate Research Unit of the University of East Anglia

- nd Average monthly rainfall for Ethiopia at location (11.85, 39.34) from 1900 - 2009. In *Climate Change Knowledge Portal*. The World Bank Group.  
[http://sdwebx.worldbank.org/climateportal/index.cfm?page=country\\_historical\\_climate &ThisRegion=Africa&ThisCCode=ETH#](http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_historical_climate&ThisRegion=Africa&ThisCCode=ETH#). Accessed: 10 September 2014.

Conway, D

- 2000 Some aspects of climate variability in the North East Ethiopian highlands - Wollo and Tigray. *Sinet: Ethiopian Journal of Science*, 32(2): 139-161.

Crawford, O.G.S.

- 1953 *Archaeology in the Field*. London: Phoenix House LTD.

Crummey, Donald

- 1980 Abyssinian Feudalism. *Past and Present*, 89: 115-38.  
1983 Ethiopian plow agriculture in the nineteenth century. *Journal of Ethiopian Studies*, 16: 1- 23.  
1998 Deforestation in Wällo: Process or Illusion? *Journal of Ethiopian Studies*, 31(1): 1-41.  
2000 *Land and Society in the Christian Kingdom of Ethiopia*. Chicago: University of Illinois Press.

Darbyshire, Iain, Henry Lamb, and Mohammed Umer

- 2003 Forest clearance and regrowth in northern Ethiopia during the last 3000 years. *The Holocene*, 13: 536-547.

Dejene, Alemneh

- 1990 *Environment, Famine and Politics in Ethiopia: A View from the Village*. Boulder, Colorado: Lynne Rienner Publishers.



Delmonaco, G., C. Margottini and D. Spizzichino

- 2010 Weathering processes, structural degradation and slope-structure stability of rock-hewn churches of Lalibela (Ethiopia). In *Weathering as a Predisposing Factor to Slope Movements*. Engineering Geology Special Publication no. 23. D. Calcaterra & M. Parise, eds. Pp. 131-147. London: The Geological Society of London.

DePloey, J and J Savat

- 1968 Contribution a l'etude de l'erosion par le splash. *Zeitschrift fur Geomorphologie, N.F.*, 12:174-193.

Derat, Marie-Laure

- 2003 *Le Domaine des Rois Ethiopiens, 1270-1527: Espace, Pouvoir, et Monarchisme*. Paris: Publications de la Sorbonne.
- 2009 Du Beg<sup>w</sup>ena au Lasta, centre et peripherie dans le royaume d'Éthiopie du XIII<sup>e</sup> au XVI<sup>e</sup> siecle. *Annales d'Éthiopie*, 24: 65-86.
- 2010 La géographie légendaire d'un <<camp royal>> éthioipen du XV<sup>e</sup> siècle. Histoire d'une construction mémorielle. *Afrique*. <http://afriques.revues.org/764>. Accessed 4 August 2011

Derat, Marie-Laure and Anne-Marie Jouquand, eds.

- 2012 <<Gabriel. Une Église Médiévale d'Éthiopie.>> *Annales d'Éthiopie*, hors-series #2. Addis Ababa, Ethiopia: De Boccard / Centre Français des Études Éthiopiennes.

Derat, Marie-Laure and H. Pennec

- 1997 Les Eglises et Monasteres Royaux d'Éthiopie. In *Ethiopia in the Broader Perspective: Papers of the XIIIth International Conference of Ethiopian Studies, Kyoto, 12-17 December, 1997*. Kyoto: Shokado Book Sellers.

Descheemaeker, Katrien, Jan Nyssen, Joni Rossi, Jean Poesen, Mitiku Haile, Dirk Raes, Bart Muys, Jan Moeyersons, and Seppe Deckers

- 2006 Sediment deposition and pedogenesis in exclosure in the Tigray highlands, Ethiopia. *Geoderma*, 132: 291-314.

Digby, Adrian

- 1964 *Maya Jades*. London: Trustees of the British Museum.

Dombrowski, Joanne

- 1971 *Excavations in Ethiopia: Lalibela and Natchabiet Caves, Begemder Province*. Ph.D. dissertation, Department of Archaeology, Boston University.

Dudal, R. and H. Eswaran

- 1988 Distribution, properties and classification of Vertisols. In *Vertisols: Their Distribution, Properties, Classification, and Management*. Larry P. Wilding and Ruben Puentes, eds. Pp. 1-22. College Station, TX: Texas A&M University.

Duffield, Lathel L.

- 1970 Vertisols and their implications for archaeological research. *American Anthropologist, New Series*, 72(5): 1055-1062.

Dunne, Thomas and William Dietrich

- 1982 Sediment sources in tropical drainage basins. In *Soil Erosion and Conservation in the tropics*. American Society of Agronomy special publication #43. W. Kussow, S.A. El-Swaify, and J. Manning, eds. Pp. 41-53. Madison, WI: American Society of Agronomy, Soil Science Society of America.

Dunnell, Robert C., and William Dancey

- 1979 Siteless surveys: a regional data collection strategy. In *Advances in Archaeological Method and Theory*, 6: 267-287.

Ethiopian Mapping Authority

- 1965 Aerial photo, Serial number 63-157, #14288. Scale 1:25. Taken 17 February. Print and .tif formats. Addis Ababa: Ethiopian Mapping Authority.
- 1982 Aerial photo, Series ET 2, S 10, #0270. Scale 1:25. Taken 23 January. Print and .tif formats. Addis Ababa: Ethiopian Mapping Authority.
- 1996 Topographic map. Series ETH 4, Sheet 1139 A1 (Kulmesk). Scale 1:50,000. Edition 1. Addis Ababa: Ethiopian Mapping Authority.

Fagan, Brian

- 1978 *In the Beginning: An Introduction to Archaeology*. Boston: Little, Brown.

Fauvelle-Aymar, Francois-Xavier, Laurent Bruxelles, Romain Mensan, Claire Bosc-Tiesse, Marie-Laure Derat, and Emmanuel Fritsch

- 2010 Rock-cut stratigraphy: sequencing the Lalibela churches. *Antiquity*, 84: 1135-1150.

Finneran, Niall

- 2003 The monasteries of Shire, Northern Ethiopia. *Ecclesiology Today*, 30: 3-10.
- 2009 Settlement archaeology and oral history in Lasta, Ethiopia: some preliminary observations from a landscape study of Lalibela. *Azania*, 44(3): 281-291.
- 2011 Lalibela in its landscape: archaeological survey at Lalibela, Lasta, Ethiopia, April to May 2009. *Azania*, 47(1): 81-98.

Finneran, Niall and Tania Tribe

- 2003 The monasteries of Shire, northern Ethiopia. *Ecclesiology Today*, 30: 3-9.
- 2004 Towards an archaeology of Ethiopian monasticism: Contexts and themes. In *Belief in the Past: The Proceedings of the 2002 Manchester Conference on Archaeology and Religion*. Timothy Insoll, ed. Pp. 63-73. Oxford: Archaeopress.

Fleur, D.

- 1987. *Measurement of tillage effects of ox-drawn implements and physical conditions in the seedbed. A study from the Arsi region of Ethiopia*. Arbetsrapport 41. International Rural Development Centre, Swedish University of Agricultural Sciences.

Food and Agriculture Organization (FAO) of the United Nations

- 1986 *Ethiopian Highlands Reclamation Study. Final Report*. Rome: Food and Agriculture Organization of the United Nations.

Frankl, Amaury, Jan Nyssen, Morgan De Dapper, Mitiku Haile, Paolo Billi, R. Neil Munro, Jozef Deckers, and Jean Poesen

- 2011 Linking long-term gully and river channel dynamics to environmental change using repeat photography (Northern Ethiopia). *Geomorphology*, 129: 238-251.

Frankl, Amaury, Jean Poessen, Jan Moeyersons, and Jan Nyssen

- 2015 Gully development in the Tigray highlands. *Landscapes and Landforms of Ethiopia*, World Geomorphological Landscapes. Paolo Billi, ed. Pp. 191-199. Dordrecht, Netherlands: Springer.

Freebairn, D.M., R.J. Loch, and D.M. Silburn

- 1996 Soil erosion and soil conservation for vertisols. In *Vertisols and Technologies for their Management*. N. Ahmad and A. Mermut, eds. Pp. 303-362. Amsterdam: Elsevier.

French, Charles, Federica Sulas, Marco Madella

2007 New geoarchaeological investigations of the valley system in the Aksum area of northern Ethiopia. *Catena*, 78: 218-233.

Friis, Ib, Sebsebe Demissew, and Paulo van Breugel

2011 *Atlas of the Potential Vegetation of Ethiopia*. Addis Ababa: Addis Ababa University Press, Shama Books.

Frostick, Lynne and Ian Reid

1983 Taphonomic significance of sub-aerial transport of vertebrate fossils on steep semi-arid slopes. *Lethaia*, 16: 157-164.

Gebregziabher, Solomon, Abdul Mounem Mouazen, Hendrik Van Brussel, Herman Ramon, Jan Nyssen, Hubert Verplancke, Mintesinot Behailu, Jozef Deckers, Josse De Baerdemaeker

2006 Animal drawn tillage, the Ethiopian ard plough, maresha: A review. *Soil & Tillage Research*, 89: 129-143.

Gebremichael, Desta, Jan Nyssen, Jean Poessen, J Deckers, Mitiku Haile, G. Govers, and Jan Moeyersons

2005 Effectiveness of stone bunds in controlling soil erosion on cropland in the Tigray highlands, Northern Ethiopia. *Soil Use and Management*, 21(3): 287-297.

General Statistical Agency, Ministry of Finance and Economic Development

2007 *Population and Housing Census 2007 Report, Amhara, Part 1: Population Size and Characteristics*. Retrieved from: <http://catalog.ihsn.org/index.php/catalog/3583>. Accessed: 15 August 2015.

Gerster, Georg

1968 *L'art éthiopien: Églises rupestres*. Paris: Zodiaque.

Gervers, Michael

2003a The rehabilitation of the Zagwe kings and the building of Dabra Sina - Golgotha - Sellassie complex in Lalibala. *Africana bulletin*, 51: 23-49.

2003b The Dabra Sina - Golgotha - Sellassie complex in Lalibala. In *Proceedings of the 6th International Conference on the History of Ethiopian Art*. B. Teffera and R. Pankhurst, eds. Pp. 388-414. Addis Ababa: Addis Ababa University Press.

Girmah, Elias, Claude Lepage and Jacques Mercier

- 2001 Peintures murales du XIIe siècle découvertes dans l'église Yemrehana Krestos en Éthiopie. *Comptes Rendus des Séances de l'Académie des Inscriptions et Belles-Lettres*, 145(1): 311-334.

Gladfelter, Bruce G.

- 1977 Geoarchaeology: the geomorphologist and archaeology. *Anitquity*, 42(4): 519-538.

Goe, M.

- 1999 Influence of slope and stone cover on tillage operations in the Ethiopian highlands. *Soil Tillage Research*, 49: 289-300.

Goldberg, Paul and Richard Macphail

- 2006 *Practical and Theoretical Geoarchaeology*. Maldan, Massachusetts: Blackwell Publishing.

Gosden, Chris and Lesley Head

- 1994 Landscape - a usefully ambiguous concept. *Archaeology in Oceania*, 29(3): 113-116.

Gosden, Chris and John Webb

- 1994 The creation of a Papua New Guinean Landscape: Archaeological evidence and geomorphological evidence. *Journal of Field Archaeology*, 21: 29-51.

Grab, Stefan

- 2002 Glacial and periglacial phenomena in Ethiopia: a review. *Permafrost and Periglacial Processes*, 13: 71-76.

Greer, J.

- 1971 Effect of excessive-rate rainstorms on erosion. *Journal of Soil and Water Conservation*, 5: 196-197

Grepperud, Sverre

- 1994 Population pressure and land degradation: the case of Ethiopia. *Journal of Environmental Economics and Management*, 30(1): 18-33.

Haile, Getatchew

- 1988 On the House of Lasta from the History of Zena Gabra'el. In *Proceedings of the Ninth International Congress of Ethiopian Studies, Moscow*. Vol 6. Pp. 7-21.

Haregeweyn, Nigussie, Jean Poesen, Jan Nyssen, Gerard Govers, Gert Verstraeten, Joris de Vente, Jozef Deckers, Jan Moeyersons, and Mitiku Haile

- 2008 Sediment yield variability in Northern Ethiopia: A quantitative analysis of its controlling factors. *Catena*, 75: 65-76.

Hastenrath, Stefan

- 1977 Pleistocene mountain glaciation in Ethiopia. *Journal of Glaciology*, 18(79): 309-313.

Head, Lesley

- 2008 Geographical scale in understanding human landscape. In *Handbook of Landscape Archaeology*. Bruno David and Julian Thomas, eds. Pp. 551-561. Walnut Creek, CA: Left Coast Press.

Heldman, Marilyn

- 1992 Architectural Symbolism, Sacred Geography and the Ethiopian Church. *Journal of Religion in Africa*, 22(3): 222- 241.

Heldman, Marilyn, and Getatchew Haile

- 1987 Who is Who in Ethiopia's Past, Part III: Founders of Ethiopia's Solomonic Dynasty. *Northeast African Studies*, 9(1): 1-11.

Hellden, U.

- 1987 *An Assessment of Woody Biomass, Community Forests, Land Use and Soil Erosion in Ethiopia*. *Lund Studies in Geography, Series C*. General, Mathematical and Regional Geography, no. 14. Lund Sweden: Lund University Press.

Henrickson, B., Ross S. Sultan Tilimo, H. Y. Wijntje-Bruggeman, and Fitssum Fitwe

- 1983 *Provisional soil depth map of Ethiopia*. Addis Ababa: Land Planning and Regulatory Department, Ministry of Agriculture.

Hoben, Allan

1973 *Land Tenure Among the Amhara of Ethiopia: The Dynamics of Cognatic Descent*. Chicago: University of Chicago Press.

Hole, F. and R. F. Heizer

1973 *An Introduction to Prehistoric Archaeology*. 3rd Edition. New York: Holt.

Holliday, Vance T.

2004 *Soils in Archaeological Research*. Oxford: Oxford University Press.

Holliday, Vance T., ed

1992 *Soils in Archaeology: Landscape Evolution and Human Occupation*.

Washington: Smithsonian Institution Press.

Holt, J.F.J

1983 Ethiopia: food for work or food for relief? *Food Policy*, 8(3): 187-201.

Horton, Robert

1945 Erosional development of streams and their drainage basins; hydrophysical approach to quantitative morphology. *Bulletin of the Geological Society of America*, 56: 275-370.

Horvath, Ronald J.

1968 Addis Ababa's eucalyptus forest. *Journal of Ethiopian Studies*, 6(1): 13-19.

Hulme, Mike

1992 Rainfall Change in Africa: 1931-1960 to 1961-1990. *International Journal of Climatology*, 12: 685-699.

Humphrey, Liz

1999 Food-for-work in Ethiopia: Challenging the Scope of Project Evaluations. *IDS Working Paper 81*. <https://www.ids.ac.uk/publication/food-for-work-in-ethiopia-challenging-the-scope-of-project-evaluations>. Accessed: 4 April 2015.

Hunting Technical Services

1976 *Tigray Rural Development Study, Annex 1. Land and Vegetation Resources*.

Hemel Hempstead, Great Britain: Hunting Technical Services Ltd.

Hurni, Hans

- 1978 Soil erosion forms in the Simen Mountains - Ethiopia (with map 1:25000). *Geographica Bernensia*, 5: 93-100.
- 1979 Semien—Äthiopien: methoden zur Erfassung der Bodenerosion. *Geomethodica*, 4: 151-182.
- 1983 *Soil Formation Rates in Ethiopia (with 8 maps, scale 1: 1,000,000)*. Ethiopian Highlands Reclamation Study, Working Paper 2. Rome: Food and Agriculture Organization of the United Nations.
- 1985 Erosion - productivity - conservation systems in Ethiopia. In *Soil conservation and productivity*. Proceedings: IV International Conference on Soil Conservation, Maracay-Venezuela, November 3-9. Pp. 654-674. Maracay, Venezuela: Sociedad Venezolana.
- 1986 *Guidelines for Development Agents on Soil Conservation in Ethiopia*. Addis Ababa: Community Forests and Soil Conservation Development Department, Ministry of Agriculture, Ethiopia.
- 1988 Degradation and conservation of the resources in the Ethiopian highlands. *Mountain Research and Development*, 8(2/3): 123-130.

Hussein, Janet and M. Adey

- 2001 Soil and water conservation strategies for Vertisols: past experiences and challenges ahead for Africa. In *The Sustainable Management of Vertisols*. IBSRAM proceedings, no. 20. J. K. Syers, F. W. T. Penning de Vries, and P. Nyamudeza, eds. Pp. 21-41. New York: CABI.

International Fund for Monuments, Inc. (UNESCO)

- 1967 *Lalibela - Phase I: Adventure in Restoration*. New York: International Fund for Monuments, Inc.

International Union of Soil Science Working Group WRB

- 2014 *World Reference Soil Base for Soil Resources*. World Soil Resources reports No. 106. Rome: Food and Agriculture Organization of the United Nations.

Johnson, Matthew

- 2007 *Ideas of Landscape*. Malden, MA: Blackwell Publishing.

Jones, A., Breuning-Madsen, H., Brossard, M., Dampha, A., Deckers, J., Dewitte, O., Gallali, T., Hallett, S., Jones, R., Kilasara, M., Le Roux, P., Micheli, E., Montanarella, L., Spaargaren, O., Thiombiano, L., Van Ranst, E., Yemefack, M., Zougmore R., eds.

- 2013 *Soil Atlas of Africa*. Luxembourg: European Commission, Publications Office of the European Union.



Joussaume, Roger, with Sylvia Barbier, Claude Bouville, Serge Cassen, and Jean-Pierre Lagasquie

- 1995 *Tiya, L'Éthiopie des mégalithes: du biface à l'art rupestre dans la corne de l'Afrique*. Poitiers, France: Association des Publications Chauvinoises.

Jutzi, Samuel

- 1988 Deep black clay soils (Vertisols): Management options for Ethiopian highlands. *Mountain Research and Development*, 8(2/3): 153-156.

Kazmin, V.

- 1972 *Geological Map of Ethiopia*. Addis Ababa: Geological Survey of Ethiopia, Ministry of Mines, Energy, and Water Resources.

Kebrom, Tekle, and Lars Hedlund

- 2000 Land cover changes between 1958 and 1986 in Kalu District, Southern Wello, Ethiopia. *Mountain Research and Development*, 20(1): 42-51.

Kepner, R. A., R. Bainer, and E. L. Barger

- 1978 *Principles of Farm Machinery*. Third Edition. Westport, CT: A.V.I. Publishing Company

Kijowska, Jolanta, Andrzej Kojowski, and Włodzimierz Rączkowski

- 2010 Politics and landscape change in Poland: c. 1940-2000. In *Landscapes Through the Lens. Aerial Photographs and Historic Environments*. Occasional Publications of the Aerial Archaeology Research Group, No. 2. David Cowley, Robin Standring and Matthew Abicht, eds. Pp. 155-166. Oxford: Oxbow Books.

King, J. A. and H. M. Miller

- 1987 The view from the midden: an analysis of midden distribution and composition at the van Sweringen site, St. Mary's City, Maryland. *Historical Archaeology*, 21(2): 37-59.

Kirkby, Mike J., Ken Atkinson, and John Lockwood

- 1990 Aspect, vegetation cover and erosion on semi-arid hillslopes. In *Vegetation and Erosion: Processes and Environment*. British Geomorphological Research Group Symposia Series. J. B. Thornes, ed. Pp. 25-39. Hoboken, New Jersey: John Wiley and Sons, Ltd.

Kirkby, A. V. and Mike J. Kirkby

- 1976 Geomorphic processes and the surface survey of archaeological sites in semi-arid areas. In *Geology: Earth Science and the Past*. D. A. Davidson and M. L. Schackley, eds. Pp. 229-253. Boulder, CO: Westview Press.

Knighton, David

- 1998 *Fluvial Forms and Processes: A New Perspective*. London: Arnold.

Kouwenhoven, J. K. and R. Terpstra

- 1970 Mixing and sorting of granules by tines. *Journal of Agricultural Engineering Research*, 15(2): 129-147.
- 1977 Sorting of glass spheres by tines. *Journal of Agricultural Engineering Research*, 22: 153-163.
- 1979 Sorting action of tines and tine-like tools in the field. *Journal of Agricultural Engineering Research*, 24: 95-113.

Krauer, J.

- 1988 *Rainfall, Erosivity and Isoerodent Map of Ethiopia*. Soil Conservation Research Project, Research Report 15. Berne, Switzerland: University of Berne.

Kryder-Reid, Elizabeth

- 1996 The construction of sanctity: landscape and ritual in a religious community. In *Landscape Archaeology: Reading and Interpreting the American Historical Landscape*. Rebecca Yamin and Karen Besherer Metheny, eds. Pp. 228-248. Knoxville, TN: University of Tennessee Press.
- 1998 The archaeology of vision in eighteenth-century Chesapeake gardens. *Annapolis Past: Historical Archaeology in Annapolis, Maryland*. Paul A. Shackel, Paul R. Mullins, and Mark S. Warner, eds. Pp. 268-290. Knoxville, TN: University of Tennessee Press.

Kur, Stanislas, trans.

- 1965 *Actes de Iyasus Mo'a, abbé du couvent de St-Etienne de Hayq*. Corpus Scriptorum Christianorum Orientalium, vol. 260 : Scriptorum Aethiopicum, tomus 50. Leuven: CSCO.

Lepage, Claude

- 1975 Peintures murales de Gannata Maryam (rapport pré-liminaire). In *Abbay: Documents pour servir à l'histoire de la civilisation éthiopienne*, 6: 59-84.
- 1976 Résumé des résultats des recherches archéologiques effectuées en Ethiopie en 1973-1974 (1966 cal. Éth.). *Annales d'Ethiopie*, 10: 328.

- 1997 Une origine possible des églises monolithiques de l'Éthiopie ancienne. *Comptes Rendus des Séances de l'Académie des Inscriptions et Belles-Lettres*, 141(1): 199-212.
- 1999 Les peintures murales de l'église Beta Maryam à Lalibala, Ethiopie. *Comptes Rendus des Séances de l'Académie des Inscriptions et Belles-Lettres*, 143(3): 901-966.
- 2002 Un métropolite égyptien bâtisseur à Lalibala (Ethiopie) entre 1205 et 1210. *Comptes Rendus des Séances de l'Académie des Inscriptions et Belles-Lettres*, 146(1): 141-174.
- 2006 Un bas-relief royal à Lalibala (Ethiopie) vers 1200. *Comptes Rendus des Séances de l'Académie des Inscriptions et Belles-Lettres*, fasc. 1: 153-173.

Lewarch, Dennis

- 1979 Effects of tillage on artefact patterning: a preliminary assessment. In *Cannon Reservoir Human Ecology Project: A Regional Approach to Cultural Continuity and Change*. Technical report of the University of Nebraska, Division of Archaeological Research. O'Brien, Michael J., and Robert E. Warren, eds. Pp. 101-149. Lincoln, Nebraska: University of Nebraska.

Lewarch, Dennis E. and Michael J. O'Brien

- 1981a The expanding role of surface assemblages in archaeological research. In *Advances in Archaeological Method and Theory*, Vol. 4. Michael B. Schiffer, ed. Pp. 297-342. New York: Academic Press.
- 1981b Effect of short term tillage on aggregate provenience surface pattern. In *Plowzone Archaeology: Contributions to Theory and Technique*. Michael J. O'Brien and Dennis E. Lewarch, eds. Vanderbilt Publications in Anthropology, no. 27. Nashville, TN: Vanderbilt University.

Lowdermilk, W. C. and H. L. Sundling

- 1950 Erosion pavement, its formation and significance. *Transactions of the American Geophysical Union*, 31(1): 96-100

Marcus, Harold G.

- 2002 *A History of Ethiopia. Updated Edition*. Berkeley: University of California Press.

Marshall, Michael H., Henry F. Lamb, Sarah J. Davies, Melanie J. Leng, Zelalem Kubsu, Mohammed Umer, and Charlotte Bryant

- 2009 Climatic change in northern Ethiopia during the past 17,000 years: A diatom and stable isotope record from Lake Ashenge. *Paleogeography, Paleoclimatology, Paleoecology*, 279: 114-127.

Marshall, Michael H., Henry F. Lamb, Dei Huws, Sarah J. Davies, Richard Bates, Jan Bloemendal, John Boyle, Melanie J. Leng, Mohammed Umer, and Charlotte Bryant  
2011 Late Pleistocene and Holocene drought events at Lake Tana, the source of the Blue Nile. *Global and Planetary Change*, 78(3-4): 147-161.

Machado, MJ, and Benito Perez-Gonzalez

1998 Paleoenvironmental changes during the last 4000 years in Tigray, Northern Ethiopia. *Quaternary Research*, 49: 312-321.

Mattsson, Jan and Anders Rapp

1991 The recent droughts in western Ethiopia and Sudan in a climate context. *Ambio*, 20(5): 172-175.

McIntosh, Susan Keech

1995 Pottery. In *Excavations at Jenné-Jeno, Hambarketolo, and Kaniana (Inland Niger Delta, Mali, the 1981 Season)*. Susan Keech McIntosh, ed. Pp. 130-213. Berkeley: University of California Press.

Meire, E., A. Frankl, A. De Wulf, Mitiku Haile, J. Deckers, J. Nyssen

2013 Land use and cover dynamics in Africa since the nineteenth century: warped terrestrial photographs of North Ethiopia. *Regional Environmental Change*, 13(3): 717-737.

Mengistu, Abebe

nd Archaeological research on the antiquities of Lalibela, Ethiopia. MA thesis. Addis Ababa University. Submitted 2010.

Mercier, Jacque

2002 Peintures du XIII<sup>e</sup> siècle dans une église de l'Angot (Éthiopie). *Annales d'Éthiopie*, 18: 143-148.

Merla, G., E. Abbate, A. Azzaroli, P. Bruni, P. Canuti, M. Fazzouli, M. Sagri, P. Tacconi  
1979 *A Geological Map of Ethiopia and Somalia*. Florence, Italy: Consiglio Nazionale delle Ricerche.

Mermut, A.R., E. Padmanabham, H. Eswaran, and G.S. Dasog

1996 Pedogenesis. In *Vertisols and Technologies for their Management*. N. Ahmad and A. Mermut, eds. Pp. 43-62. Amsterdam: Elsevier.

Mesfin, Tadesse

- 1993 The physiognomy and floristic composition of the vegetation on some degraded hillsides in southern Wello, Ethiopia. *Opera Botanica*, 121: 661–71.

Messing, Simon D.

- 1957 Further comments on resin-coated pottery: Ethiopia. *American Anthropologist*, 59: 134.

Michels, Joseph

- 2005 *Changing Settlement Patterns in the Aksum-Yeha Region of Ethiopia: 700 BC – AD 850*. Cambridge Monographs in African Archaeology No. 64, BAR International Series 1466. Oxford: Archaeopress.

Miguel, A.

- 1959 Reconnaissance dans Lasta. *Annales D'Éthiopie*, 3: 1-45.

Milkias, Paulos

- 2011 *Ethiopia (Nations in Focus)*. Santa Barbara, CA: ABC-CLIO.

Moeyersons, Jan

- 1983 Measurements of splash-saltation fluxes under oblique rain. *Catena Supplement*, 4: 9-13.

Moeyersons, Jan and J. De Ploey

- 1976 Quantitative data on splash erosion simulated on unvegetated slopes. *Zeitschrift für Geomorphologie Supplementband*, 25: 120-131.

Mohr, Paul A.

- 1971 *The Geology of Ethiopia*. Addis Ababa: Haile Selassie I University Press.  
1983 Ethiopian flood basalt province. *Nature*, 303 (16 June): 577-584.

Mohr, Paul A and Bruno Zanettin

- 1988 The Ethiopian Flood Basalt Province. *Petrology and Structural Geology*, 3: 63-110.

Monte Della Corte, A. A.

1940 *Lalibelà. Le chiese ipogee e monolitiche e gli altri monumenti medievali dei Lastà*. Rome: Società italiana arti grafiche.

Montgomery, David R.

2007 Soil erosion and agricultural sustainability. *Proceedings of the National Academy of Sciences, USA*, 104(33): 13268-13272.

Muche, Habtamu, Melesse Temesgen, and Fantaw Yimer

2013 Soil loss predicating using USLE and MUSLE under conservation tillage integrated with 'fanya juus' in Choke Mountain, Ethiopia. *International Journal of Agricultural Sciences*, 3(10): 46-52.

Munsell Color

2009 *Munsell Soil-Color Charts*. Grand Rapids, MI: Munsell Color, X-rite

Munro, R. Niel, J. Deckers, Mitiku Haile, A.T. Grove, J. Poesen, and J. Nyssen

2008 Soil landscapes, land cover change and erosion features of the Central Plateau region of Tigray, Ethiopia: Photo-monitoring with an interval of 30 years. *Catena*, 75: 55-64.

Mwendera, E.J. and M.A. Mohamed Saleem

1997 Infiltration rates, surface runoff, and soil loss as influenced by grazing pressure in the Ethiopian highlands. *Soil Use and Management*, 13: 29-35.

Mwendera, E.J., M.A. Mohamed Saleem, and A. Dibabe

1997 The effect of livestock grazing on surface runoff and soil erosion from sloping pasture lands in the Ethiopian highlands. *Australian Journal of Experimental Agriculture*, 37: 421-430.

Navazo, Marta, and Carlos Diez

2008 Redistribution of archaeological assemblages in plowzones. *Geoarchaeology: An International Journal*, 23(3): 323-333.

Nichols, M. L. and I. F. Reed

1934 Soil dynamics: VI, physical reactions of soils to moldboard surfaces. *Agricultural Engineering*, 15: 187-190.

Nyssen, Jan, Mitiku Haile, Jozef Naudts, Neil Munro, Jean Poesen, Jan Moeyersons, Amaury Frankl, Jozef Deckers, and Richard Pankhurst  
 2009 Desertification? Northern Ethiopia re-photographed after 140 years. *Science of the Total Environment*, 407: 2749-2755.

Nyssen, Jan, Jan Moeyersons, J. Deckers, Mitiku Haile, and Jean Poesen  
 2015 The amba landscape of the Ethiopian highlands, shaped by rockfall. *Landscapes and Landforms of Ethiopia*, World Geomorphological Landscapes. Paolo Billi, ed. Pp. 179-189. Dordrecht, Netherlands: Springer.

Nyssen, Jan, Jean Poesen, and Jozef Deckers  
 2009 Land degradation and soil and water conservation in tropical highlands. *Soil & Tillage Research*, 103: 197-202.

Nyssen, Jan, Jean Poesen, Mitiku Haile, Jan Moeyersons, and Jozef Deckers  
 2000 Tillage erosion on slopes with soil conservation structures in the Ethiopian highlands. *Soil & Tillage Research*, 57: 115-127.

Nyssen, Jan, Jean Poesen, Sil Lanckriet, Miro Jacob, Jan Moeyersons, Mitiku Haile, Nigussie Haregewyn, R. Neil Munro, Katrien Descheemaeker, Enyew Adgo, Amaury Frankl, and Jozef Deckers  
 2015 Land degradation in the Ethiopian Highlands. *Landscapes and Landforms of Ethiopia*, World Geomorphological Landscapes. Paolo Billi, ed. Pp. 369-385. Dordrecht, Netherlands: Springer.

Nyssen, Jan, Jean Poesen, Jan Moeyersons, Jozef Deckers, Mitiku Haile, and Andreas Lang  
 2004 Human impact on the environment in the Ethiopian and Eritrean highlands - a state of the art. *Earth-Science Reviews*, 64: 273-320.

Nyssen, Jan, Jean Poesen, Jan Moeyersons, Mitiku Haile, and Jozef Deckers  
 2008 Dynamics of soil erosion rates and controlling factors in the Northern Ethiopian Highlands - towards a sediment budget. *Earth Surface Processes and Landforms*, 33: 695-711.

Nyssen, Jan, Jean Poesen, Jan Moeyersons, Edith Luyten, Maude Veyret-Picot, Jozef Deckers, Mitiku Haile, and Gerard Govers  
 2002 Impact of road building on gully erosion risk: A case study from the Northern Ethiopian highlands. *Earth Surface Processes and Landforms*, 27:1267-1283.

- Nyssen, Jan, Jean Poesen, Maude Vyret-Picot, Jan Moeyersons, Mitiku Haile, Jozef Deckers, Joke Dewit, Jozef Naudts, Kassa Teka, and Gerard Govers  
 2006 Assessment of gully erosion rates through interviews and measurements: a case study from northern Ethiopia. *Earth Surface Processes and Landforms*, 31: 167-185.
- Nyssen, Jan, Getachew Simegn, and Nurhussen Taha  
 2009 An upland farming system under transformation: Proximate causes of land use change in Bela-Welleh catchment (Wag, Northern Ethiopian Highlands). *Soil & Tillage Research*, 103: 231-238.
- Nyssen, Jan, H. Vandenreyken, Jean Poesen, Jan Moeyersons, J. Deckers, Mitiku Haile, C. Salles, and G. Govers.  
 2005 Rainfall erosivity and variability in the Northern Highlands. *Journal of Hydrology*, 311: 172-187.
- Odell, George H., and Frank Cowan  
 1987 Estimating tillage effects on artifact distributions. *American Antiquity*, 52(3): 456-484.
- Osmon, M. and P. Sauerborn  
 2002 A preliminary assessment of characteristics and long term variability of rainfall in Ethiopia - basis for sustainable land use and resource management. In *Challenges to Organic Farming and Sustainable Land Use in the Tropics and Subtropics*. Deutscher Tropentag 2002. Witztenhausen, Germany: German Institute for Tropical and Subtropical Agriculture GmbH .
- Pankhurst, Richard  
 1970 A preliminary history of Ethiopian measures, weights and values - (part 3). *Journal of Ethiopian Studies*, 8(1): 45-85.  
 1995 The history of deforestation and afforestation in Ethiopia prior to World War I. *Northeast African Studies*, 2(1): 119-133.
- Pedersen, Henning and Bent Hasholt  
 1995 Influence of wind speed on rainsplash erosion. *Catena*, 24: 39-54.
- Phillipson, David W.  
 2004 The Aksumite roots of medieval Ethiopia. *Azania*, 39(1): 77-89.  
 2009 *Ancient Churches of Ethiopia*. New Haven, Connecticut: Yale University Press.



- 2012 *Foundations of an African Civilization. Aksum & the Northern Horn, 1000 BC - AD 1300*. Rochester, NY: James Currey.

Phillipson, Laurel

- 2013 Lithic tools used in the manufacture of pre-Aksumite ceramics. *Azania*, 48(3): 380-402.

Pierson, Thomas C.

- 2005 Hyperconcentrated flow - transition process between water flow and debris flow. In *Debris-flow Hazards and Related Phenomena*. Matthias Jakob and Oldrich Hungr, eds. Pp. 159-202. Chichester, UK: Springer in assoc. with Praxis Publishing.

Poesen, Jan

- 1987 Transport of rock fragments by rill flow - a field study. *Catena Supplement*, 8: 35-54.
- 2005[1992] Mechanisms of overland flow generation and sediment production on loamy and sandy soils with and without rock fragments. In *Overland Flow: Hydraulics and Erosion Mechanisms*. Taylor and Francis e-library edition. Anthony Parsons and Athol Abrahams, eds. Pp. 262-292. London: Routledge.

Poesen, Jan and J. Savat

- 1981 Detachment and transportation of loose sediments by raindrop splash. Part II: Detachability and transport ability measurements. *Catena*, 8: 19-41.

Poissonnier, Bertrand, Aurèle Letricot, François-Xavier Fauvelle-Aymar

- 2012 Sept céramiques remarquables de Ketetiya (Wällo) en contexte archéologique. In <<La culture Shay d'Éthiopie (Xe-XIVe siècle)>>. *Annales d'Éthiopie*, hors série n° 3. François-Xavier Fauvelle-Aymar and Bertrand Poissonnier, eds. Addis Ababa, Ethiopia: De Boccard / CFEE.

Price, Simon, Jonathan R. Ford, Anthony H. Cooper, and Catherine Neal

- 2011 Humans as major geological and geomorphological agents in the Anthropocene: the significance of artificial ground in Great Britain. *Philosophical Transactions of the Royal Society*, 369: 1056-1085.

Quinn, Patrick Sean

nd *Petrographic Analysis of Medieval Ceramics from Lalibela, Ethiopia*. Ceramic Petrography Analytical Service, University College London Institute of Archaeology. Prepared 4 October 2013 for Dr. Tania Tribe.

Rapp, George and Christopher Hill

2006 *Geoarchaeology: The Earth-Science Approach to Archaeological Interpretation*. Second Edition. New Haven: Yale University Press.

Redman, Charles L.

1978 Multivariate artifact analysis: a basis for multidimensional interpretation. In *Social Archaeology: Beyond Subsistence and Dating*. Charles Redman et al. eds. Pp. 159-192. New York: Academic Press.

Redman, Charles L. and Patty Jo Watson

1970 Systemic, intensive surface collection. *American Antiquity*, 35(3): 279-291.

Reeves, Dache M.

1936 Aerial photography and archaeology. *American Antiquity*, 2(2): 102-107.

Reid, Ian and Lynne Frostick

1985 Arid zone slopes and their archaeological material. In *Themes in Geomorphology*. A. Pitty, ed. Pp. 141-157. Beckenham, England: Croom Helm.

Renard, K. G., G. R. Foster, G. A. Weesies, D. K. McCool, D. C. Yoder, et al.

1997 *Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE)*. Agricultural Handbook 703. Washington, DC: United States Department of Agriculture.

Renfrew, Colin

1976 Archaeology and the Earth Sciences. In *Geoarchaeology: Earth Science and the Past*. D.A. Davidson and M.L. Shackley, eds. Pp 1-5. London: Duckworth.

Richards, Thomas

2008 Survey strategies in landscape archaeology. In *Handbook of Landscape Archaeology*. Bruno David and Julian Thomas, eds. Pp. 551-561. Walnut Creek, CA: Left Coast Press.

Rick, John W.

- 1976 Downslope movement and archaeological intrasite spatial analysis. *American Antiquity*, 41(2): 133-144.

Roper, Donna C.

- 1976 Lateral displacement of artifacts due to plowing. *American Antiquity*, 41(3): 372-375.

Savat, J. and J. De Ploey

- 1982 Sheetwash and rill development by surface flow. In *Badland Geomorphology and Piping*. R. B. Bryan and A. Yair, eds. Pp. 113-126. Norwich, UK: Geobooks.

Schiffer, Michael Brian

- 1972 Archaeological Context and Systemic Context. *American Antiquity*, 37(2): 156-165.  
 1976 *Behavioral Archaeology*. New York: Academic Press.  
 1987 *Formation Processes of the Archaeological Record*. Albuquerque: University of New Mexico Press.  
 1995 *Behavioral Archaeology, First Principles*. Salt Lake City: University of Utah Press.

Schmidt, Peter R.

- 1997 *Iron Technology in East Africa: Symbolism, Science, and Archaeology*. Bloomington, Indiana: Indiana University Press.

Sebsebe, Demisew

- 1998 A study of the vegetation and floristic composition of southern Wallo, Ethiopia. *Sinet: Journal of Ethiopian Sciences*, 31: 159-92.

Seleshi, Yilma, and Ulrich Zanke

- 2004 Recent changes in rainfall and rainy days in Ethiopia. *International Journal of Climatology*, 24: 973-983.

Sellassie, Sergew Hable

- 1972 *Ancient and Medieval Ethiopian History to 1270*. Addis Ababa: Addis Ababa University Press.

Shaw, Charles F.

1929 Erosion pavement. *Geographical review*, 19(4): 638-641.

Shiferaw, Abate

2011 Evaluating the land use and land cover dynamics in Borena Woreda of South Wollo highlands, Ethiopia. *Journal of Sustainable Development in Africa*, 13(1): 87-107.

Shinn, David H., and Thomas P. Ofcansky

2013 *Historical Dictionary of Ethiopia*. Second Edition. Lanham, UK: The Scarecrow Press, Inc.

Sinopoli, Carla M.

1991 *Approaches to Archaeological Ceramics*. New York: Plenum Press.

Steinberg, J. M.

1996 Ploughzone sampling in Denmark: isolating and interpreting site signatures from disturbed contexts. *Antiquity*, 70: 368-390.

Stern, Nicola

2008 Stratigraphy, depositional environments, and paleolandscape reconstruction in landscape archaeology. In *Handbook of Landscape Archaeology*. Bruno David and Julian Thomas, eds. Pp. 365-378. Walnut Creek, CA: Left Coast Press.

Talmage, Valerie, and Olga Chesler

1977 *The importance of small, surface, and disturbed sites as sources of significant archaeological data*. Washington, D.C.: Office of Archaeology and Historic Preservation, National Park Service.

Tamene, L., S. J. Park, R. Diku, and P. L. G. Vlek

2006 Analysis of factors determining sediment yield variability in the highlands of northern Ethiopia. *Geomorphology*, 76: 76-91.

Tamrat, Tadesse

2009[1972] *Church and State in Ethiopia*. Second Print. London: Oxford University Press.

Tegene, Belay

- 1998 Pedogenesis and soil-geomorphic relationships on the piedmont slopes of Wurgo Valley, outhern Wello, Ethiopia. *SINET: Ethiopian Journal of Science* 21(1): 91-111.
- 2002 Land-cover / land-use changes in the Derekolli catchment of the South Wello Zone of Amhara Region, Ethiopia. *East African Social Sciences Research Review*, 18(1): 1-20.

Tekle, Kebrom adn Lars Hedlund

- 2000 Land cover changes between 1958 and 1986 in Kalu District, Southern Wello, Ethiopia. *Mountain Research and Development*, 20(1): 42-51.

Tesfaye, Habtamu

- nd Archaeological Survey in Southern Wollo: Ketetiya and its Environs. MA thesis. Addis Ababa University. Submitted 2009.

Tribe, Tania

- 2014 *The Archaeology of the Dead in Northern Ethiopia*. End of Fieldwork Report (November 2014).

Turkelboom, F., J. Poesen, and G. Trebuil

- 2008 The multiple land degradation effects caused by land-use intensification in tropical steepplands: A catchment study from northern Thailand. *Catena*, 75: 102-116.

Van de Wauw, J. G. Baert, J. Moeyersons, J. Nyssen, K. De Geyndt, Nurhussein Taha, Amanuel Zenebe, J. Poesen, J. Deckers

- 2008 Soil-landscape relationships in the basalt-dominated highlands of Tigray, Ethiopia. *Catena*, 75: 117-127.

Virgo, K.J., and R.N. Munro

- 1978 Soil and erosion features of the central plateau region of Tigray, Ethiopia. *Geoderma*, 20: 131-187.

Virmani, S.M., K. L. Sahrawat, J. R. Burford

- 1982 Physical and chemical properties of Vertisols and their management. In *Twelfth International Congress of Soil Science*, 8-16 February 1982, New Dehli, India.

Wainwright, John and J. B. Thornes

- 1991 Computer hardware simulation of archaeological sediment transport of hillslopes. In *Computer Applications and Quantitative Techniques in Archaeology, 1990*. BAR International Series 565. K. Lockyear and S. Rahtz, eds. Pp. 183-194. Oxford: British Archaeological Reports.

Wainwright, John

- 1992 Assessing the impact of erosion on semi-arid archaeological sites. In *Past and Present Soil Erosion: Archaeological and Geographical Perspectives*. Pp. 228-241. Oxford: Oxbow.
- 1994 Erosion of archaeological sites: Results and implications of a site simulation model. *Geoarchaeology*, 9(3): 173-201.

Waters, Michael R.

- 1992 *Principles of Geoarchaeology: A North American Perspective*. Tucson: University of Arizona Press.

Webb, Patrick, and Shubh K. Kumar

- 1995 Food and cash for work in Ethiopia: Experiences during famine and macroeconomic reform. In *Employment for Poverty Reduction and Food Security*. Joachim von Braun, ed. Pp 201-219. Washington, DC: International Food Policy Research Institute.

Wells, Lisa E.

- 2001 A geomorphological approach to reconstructing archaeological settlement patterns based on surficial artifact distribution: replacing humans on the landscape. In *Earth Sciences and Archaeology*. Paul Goldberg, Vance Holliday, and C. Reid Ferring, eds. Pp. 107-142. New York: Kluwer Academic / Plenum Publishers.

Wilding, Larry P. and Ruben Puentes, eds.

- 1988 *Vertisols: Their Distribution, Properties, Classification, and Management*. College Station, TX: Texas A&M University.

Wilding, Larry P. and D. Tessier

- 1988 Genesis of Vertisols: Shrink-swell phenomena. In *Vertisols: Their Distribution, Properties, Classification, and Management*. Larry P. Wilding and Ruben Puentes, eds. Pp. 55-81. College Station, TX: Texas A&M University.

Wilding, R. F. and S. C. Munro-Hay

- 1989 The pottery. In *Excavations at Aksum*. Memoire 10 of the British Institute in East Africa. S. C. Munro-Hay, ed. Pp. 235-316. London: British Institute in East Africa.

Williams, J.R.

- 1975 Sediment-yield prediction with Universal Equation using runoff energy factor. In *Present and Prospective Technology for Predicting Sediment Yield and Sources*. Pp. 244-252. New Orleans: United States Department of Agriculture.

Wischmeier, Walter H. and Dwight D. Smith

- 1978 *Predicting Rainfall Erosion Losses - A Guide to Conservation Planning*. Washington, D.C.: United States Department of Agriculture.

Woiien, Halvor

- 1995a Deforestation, information and citations: A comment on environment degradation in Highland Ethiopia. *GeoJournal*, 37(4): 501-511.
- 1995b Woody plant cover and farming compound distribution on the Mafud Escarpment, Ethiopia. An aerial photo interpretation of changes 1957-1986. *Working Paper on Ethiopian Development*, no. 9: August. Trondheim: University of Torndheim.

Yimer, Fantaw, Stig Ledin, Abdu Abdelkadir

- 2006 Soil property variations in relation to topographic aspect and vegetation community in the south-eastern highlands of Ethiopia. *Forest Ecology and Management*, 232: 90-99.

## **Appendix A**

### **Shovel Tests Results**

The following tables record key data on the shovel tests undertaken at Gännäta Maryam as recorded in the field, and as discussed previously in Chapter 4 and mapped in Figure 4.12. The headers indicate the area of the shovel test and the shovel test number or sequence (e.g. "GMTM: A; ST: North 1" means "Gännäta Maryam, Area A; Shovel Test 'North 1'"). Depth measurements recorded with a "+" sign indicate that the excavation did not continue beyond this depth, though the soil stratum did continue.

Table A.1. GMTM: A; ST: North 1

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	15 cm	clay loam	5Y3/2		plow-zone: Vertisol
15 cm	70 cm+	sandy clay	10YR2/2		compacted black clay

Table A.2. GMTM: A; ST: North 2

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	17 cm	clay loam	5Y3/1		plow-zone: Vertisol
17 cm	70 cm+	sandy clay	10YR2/2		compacted black clay

Table A.3. GMTM: A; ST: North 3

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	32 cm	silty sand	10YR2/2		sandy erosion gully
32 cm	43 cm	silty sand	10YR2/2		arbitrary stratum; same as above
43 cm	75 cm	silty sand and gravel	2.5YR3/3		arbitrary stratum; same as above
75 cm	83 cm	sandy gravel transitioning to bedrock	5YR3/2		decomposing bedrock



Table A.4. GMTM: A; ST: North 4

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	15 cm	clay loam	5Y3/1		plow-zone: Vertisol
15 cm	40 cm+	sandy clay	10YR2/2		compacted black clay

Table A.5. GMTM: A; ST: North 5

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	10 cm	clay loam	5Y3/1		plow-zone: Vertisol
10 cm	35 cm	sandy clay	10YR2/2		compacted black clay

Table A.6. GMTM: A; ST: West 1

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	8 cm	sandy silt	10YR3/2-3		plow zone
8 cm	20 cm	sandy silt w/ calcite crystals	10YR3/2-3		crystals = ~2-4mm diam.
20 cm	70 cm+	sandy silt with calcite and gravel	10YR3/2		decomposing bedrock

Table A.7. GMTM: A; ST: West 2

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	15 cm	silt loam	10YR3/2-3	1 ceramic	plow zone
15 cm	25 cm	silt loam	10YR3/2-3		below plow zone, more compact
25 cm	30 cm	silt loam w/ calcite	10YR3/2-3		crystals = ~2-4mm diam.
30 cm	75 cm+	sandy silt and gravel	10YR3/2		decomposing bedrock

Table A.8. GMTM: A; ST: West 3

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	15 cm	silt loam	10YR3/2-3	5 ceramics	plow zone
15 cm	30 cm	silt loam	10YR3/2-3	3 ceramics	below plow zone, more compact
30 cm	40 cm	silt loam w/ calcite	10YR3/2-3		crystals = ~2-4mm diam.
40 cm	75 cm+	sandy silt and gravel	2.5YR3/2		decomposing bedrock

Table A.9. GMTM: A; ST: West 4

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	13 cm	loose silt loam	10YR3/2	5 ceramics	plow zone abutting retaining wall feature
13 cm	25 cm	silt loam	10YR3/2	9 ceramics; 1 lithic; 1 bone	subsoil, more compact
25 cm	45 cm	laminar silt	10YR3-4/2	9 ceramics; 1 bone	alluvial laminae abutting retaining wall feature; many small flecks of charcoal
45 cm	60 cm	sandy silt	2.5YR3/2	1 ceramic; 1 bone	mottled with streaks of clay and calcite
60 cm	75 cm	sandy clay w/ calcite	2.5YR3/2		very hard-packed

Table A.10. GMTM: A; ST: West 5

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	10 cm	loose silt loam	10YR3/2	14 ceramics, 1 bone	plow zone
10 cm	15 cm	silt loam	10YR3/2		subsoil, more compact
15 cm	70 cm+	course silt and calcite sand	2.5YR4/2	1 tooth	white and yellow calcareous sand, possibly decomposing bedrock

Table A.11. GMTT: B; ST: 1 - middle of hilltop

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	10 cm	silt w/ coarse gravel	10YR3/3	7 ceramics	old plow zone; deflated w/ crust of gravel
10 cm	15 cm	silt w/ coarse gravel	10YR3/3		same as previous, more compacted
15 cm	30 cm	silt w/ decomposing bedrock	10YR3/3		mottled with yellow and grey soil
30 cm	35 cm	silt w/ decomposing bedrock	10YR3/3		same as previous, w/ ashy inclusions/charcoal and red earth
35 cm	65 cm+	silt and masses of friable bedrock	2.5YR4-5/3		

Table A.12. GMTM: C; ST: East 1

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	10 cm	sandy silt	10YR3/3	4 ceramics; 1 lithic	plow zone
10 cm	80 cm	sandy silt	7.5YR2.5/2	9 ceramics	identical to plow zone but damper and more compacted; artifacts present through all depths

Table A.13. GMTM: C; ST: East 2

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	10 cm	sandy silt	10YR3/3	2 ceramics; 2 lithics	old plow zone - not plowed within recent years; visual evidence of recent alluvial washes over surface
10 cm	40 cm	silt loam	7.5YR2.5/2	12 ceramics; 1 bone; 1 lithic	finer texture, less alluvial sand
40 cm	80 cm+	silt loam	7.5YR2.5/2		arbitrary stratum division

Table A.14. GMTM: C; ST: East 3

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	8 cm	silt loam	10YR3/3	2 ceramics	old plow zone
8 cm	55 cm	silt loam	10YR3/3	3 ceramics	
55 cm	75 cm+	silt loam	10YR3/3	1 ceramic	arbitrary division

Table A.15. GMTM: C; ST: Southwest 1

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	15 cm	silt loam	7.5YR3/2	2 ceramics	plow zone
15 cm	58 cm	silt loam	7.5YR3/2	18 ceramics (2-3 broken from one piece while excavating)	subsoil
58 cm	80 cm	silt loam and fine gravel	10YR3/3	12 ceramics	transition was not immediately noticed & strata may have begun earlier; profile and hand excavations suggest fine stratification of this soil and previous soil types.
80 cm	85 cm	silty sand	10Yr3/2	1 lithic	appears similar to alluvial sand in current stream beds

Table A.16. GMTM: C; ST: Southwest 2

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	15 cm	sandy silt	10YR3/3	6 ceramics	plow zone adjacent to footpath/upper terrace wall
15 cm	50 cm	silt loam	10YR3/3	6 ceramics	
50 cm	80 cm	clay silt	7.5YR3/2	1 ceramic	compacted

Table A.17. GMTM: C; ST: Southwest 3

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	14 cm	clay loam	7.5YR3/2	2 ceramics	plow zone
14 cm	40 cm	clay loam	10YR2/2	2 ceramics; 1 tooth	
40 cm	75 cm+	silty clay	10YR2/2	3 ceramics in first bucket	very sticky, wet clay

Table A.18. GMTM: C; ST: Southwest 4

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	13 cm	clay loam	7.5YR2.5-3/2		plow zone, some charcoal fleck. Residents adjacent to unit currently tossing ash into fields
13 cm	35 cm	clay loam	7.5YR2.5-3/2		subsoil, some charcoal flecks
35 cm	60 cm	sandy clay	7.5YR2.5-3/2	1 ceramic	much charcoal, some gravel, possibly in thin strata
60 cm	75 cm+	sandy clay	10YR2/2		some charcoal flecks

Table A.19. GMTM: C; ST: Southwest 5

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	15 cm	clay loam	7.5YR3/2	2 ceramics	approximately 20m east of wadi
15 cm	22 cm	silty loam	10YR2/2		
22 cm	48 cm	sandy silt	10YR2-3/2	3 ceramics	
48 cm	80 cm+	clay loam	10YR2/2		

Table A.20. GMTM Valley Transect; ST 1

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	10 cm	silt w/ some gravel	10YR3/3	3 lithics	dry, slightly deflated-looking topsoil, old plow zone?
10 cm	19 cm	silt w/ some gravel	10YR3/3		more compact, below root zone
19 cm	38 cm	sandy silt and gravel	10YR3-4/3		coming onto decomposing rock
38 cm	40 cm+	bedrock			sterile bedrock

Table A.21. GMTM Valley Transect; ST 2

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	13 cm	silty loam	10YR2-3/2	1 ceramic	plow zone
13 cm	20 cm	silty loam	10YR2-3/2		subsoil
20 cm	35 cm	silty clay	10YR2/2		hard-packed clay subsoil like Area A, North transect

Table A.22. GMTM Valley Transect; ST 3

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	12 cm	silt and some gravel	10YR4/3		plow zone, far downslope, heavily eroded surface
12 cm	16 cm	silt and some gravel	10YR4/4		slightly rockier than above
16 cm	21 cm+	bedrock			

Table A.23. GMTM Valley Transect; ST 4

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	14 cm	clay loam	5Y3/1	1 ceramic	plow zone, Vertisol
14 cm+		sandy clay			hard-packed clay

Table A.24. GMTM Valley Transect; ST 5

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	15 cm	fine silt	10YR3/2-3	1 ceramic	plow zone, very fine dusty soil
15 cm	37 cm	fine silt	10YR3/3	1 ceramic	subsoil, very fine soil
37 cm	55 cm	sandy silt	7.5YR3/4		some rock fragments
55 cm	63 cm+	friable bedrock			

Table A.25. GMTM Valley Transect; ST 6

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	7 cm	clay silt	10YR4/2-3		very old plow zone
7 cm	14 cm	clay silt and small gravel	10YR4/2-3		subsoil
14 cm	18 cm	clay silt and decomposing bedrock	10YR4/2-3		
18 cm+		bedrock			

Table A.26. GMTM Valley Transect; ST 7

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	10 cm	silty loam			deflated, crusty surface over old plow zone
10 cm	14 cm	silty loam			subsoil
14 cm	55 cm	silty loam			mottled with black clay in first few cm
55 cm	63 cm	silt			densely packed
63 cm	75 cm+	sandy silt			lightly packed

Table A.27. GMAD: D; ST: 1

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	15 cm	silt	10YR3/2	6 ceramics	deflated surface, not recently plowed
15 cm	17 cm+	silt and large rocks	10YR3/2		large rocks, loosely consolidated. Appears to be an anthropogenic feature like a wall

Table A.28. GMAD: D; ST: 2

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	16 cm	silt	10YR3/2	8 ceramics, 1 bone fragment	deflated, crusty surface over old plow zone
16 cm	20 cm	silt	10YR3/2	2 ceramics	subsurface
20 cm	36 cm	silt, burned earth and charcoal	10YR2-3/2	burned earth & plaster?	appears to be a burned surface
36 cm	75 cm+	silt and decomposing bedrock	10YR3/3-4		apparently sterile subsoil

Table A.29. GMAD: D; ST: 3

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	12 cm	silt	10YR3/2	7 ceramics (3 from surface)	old plow zone, all ceramics from first bucket
12 cm	20 cm	silt and fine gravel	7.5YR3/2-3	2 ceramics	below plow zone
20 cm	30 cm+	silt and decomposing bedrock			

Table A.30. GMAD: D; ST: 4

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	17 cm	silt with gravel and building stones	10YR3/3	8 ceramics	center of recently abandoned house
17 cm	35 cm +	silt and decomposing bedrock	10YR3/3	1 ceramic	coming down onto bedrock, increasingly more difficult to excavate

Table A.31. GMAD: D; ST: 5

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	14 cm	silt	10YR3/2		plow zone
14 cm	45 cm+	silt and fine gravel	7.5YR3/3		coming onto bedrock, very hard packed and increasingly difficult to excavate

Table A.32. GMAD: E; North-Northwest 1

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	15 cm	silty loam	10YR3/3	5 ceramics	plow zone
15 cm	45 cm	sandy silt	10YR3/3		subsoil to bedrock

Table A.33. GMAD: E; North-Northwest 2

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	15 cm	silty loam	10YR3/2		plow zone
15 cm	55 cm	clay loam and decomposed bedrock	10YR3/4		subsoil to bedrock

Table A.34. GMAD: E; South-Southeast 1

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	14 cm	silty loam and small gravel	10YR3/2-3	16 ceramics	not recently plowed, slightly deflated surface; gravel possibly from adjacent abandoned house
14 cm	22 cm	silty loam	10YR3/2-3	2 ceramics	large grey stones like possible feature
22 cm	65 cm	sandy silt and decomposing bedrock	7.5YR3/2		excavated adjoining to stones, no further material or features to bedrock

Table A.35. GMAD: E; South-Southeast 2

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	14 cm	silt	10YR3/2-3	4 ceramics; 2 lithics	plow zone / edge of a threshing surface
14 cm	20 cm	silty loam and gravel	7.5YR3/3-4		subsoil below plow zone
20 cm	60 cm	sandy loam and decomposing bedrock	7.5YR3/3		decomposing rock to bedrock

Table A.36. GMAD: E; South-Southeast 3

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	14 cm	silty loam	10YR3/3	5 ceramics, 1 lithic, 2 bones	plow zone
14 cm	25 cm+	silty loam and gravel	10YR3/3		rocky, becomes too dense and rocky for a shovel test

Table A.37. GMAD: E; South-Southeast 4

Opening Depth	Closing Depth	Soil Type	Munsell	Cultural Material	Notes
0 cm	14 cm	silty loam	7.5YR3/3	1 lithic	plow zone
14 cm	63 cm+	clayey silt	7.5YR2.5/3	1 lithic, 1 bone fragment	undifferentiated subsoil. Artifacts from first few centimeters



## **Appendix B**

### **Radiometric Dating Results**

The following is a report prepared by Beta Analytics on the AMS dating of four charcoal samples I submitted. The samples were retrieved from archaeological features in the study area. Sample 4008-GS97 (Beta - 363381) was recovered from Unit 4, locus 8, the large pit feature at Tarla Terrara. Sample 5006-GS103 (Beta - 363382) was recovered from Unit 5, locus 6, the smaller pit feature filled with layers of ash lower on the slope of Tarla Terrara. Sample 8004-GS110 (Beta - 363383) was recovered from the living surface of Unit 8, the occupational site excavated at Kiflie Mado. Likewise, sample 8006-GS111 (Beta - 363384) was recovered from the hearth feature of the same unit.



*Consistent Accuracy . . .  
... Delivered On-time*

Beta Analytic Inc.  
4985 SW 74 Court  
Miami, Florida 33155 USA  
Tel: 305 667 5167  
Fax: 305 663 0964  
Beta@radiocarbon.com  
www.radiocarbon.com

**Darden Hood**  
President  
  
**Ronald Hatfield**  
**Christopher Patrick**  
Deputy Directors

November 19, 2013

Dr. Brian Clark  
Rice University  
Department of Anthropology  
MS-20  
610 Main Street  
Houston, TX 77005  
USA

RE: Radiocarbon Dating Results For Samples 4008-GS97, 5006-GS103, 8004GS110, 8006-GS111

Dear Dr. Clark:

Enclosed are the radiocarbon dating results for four samples recently sent to us. They each provided plenty of carbon for accurate measurements and all the analyses proceeded normally. The report sheet contains the dating result, method used, material type, applied pretreatment and two-sigma calendar calibration result (where applicable) for each sample.

All results (excluding some inappropriate material types) which are less than about 42,000 years BP and more than about ~250 BP include a calendar calibration page (also digitally available in Windows metafile (.wmf) format upon request). Calibration is calculated using the newest (2009) calibration database with references quoted on the bottom of the page. Multiple probability ranges may appear in some cases, due to short-term variations in the atmospheric <sup>14</sup>C contents at certain time periods. Examining the calibration graph will help you understand this phenomenon. Don't hesitate to contact us if you have questions about calibration.

We analyzed these samples on a sole priority basis. No students or intern researchers who would necessarily be distracted with other obligations and priorities were used in the analyses. We analyzed them with the combined attention of our entire professional staff.

The cost of the analysis was charged to the MASTERCARD card provided. Thank you. As always, if you have any questions or would like to discuss the results, don't hesitate to contact me.

Sincerely,

Digital signature on file



## REPORT OF RADIOCARBON DATING ANALYSES

Dr. Brian Clark

Report Date: 11/19/2013

Rice University

Material Received: 10/31/2013

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 363381 SAMPLE : 4008-GS97 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1530 to 1540 (Cal BP 420 to 410) AND Cal AD 1550 to 1550 (Cal BP 400 to 400) Cal AD 1630 to 1670 (Cal BP 320 to 280) AND Cal AD 1780 to 1800 (Cal BP 170 to 150) AND Cal AD 1940 to 1950 (Cal BP 0 to 0)	210 +/- 30 BP	-22.8 o/oo	250 +/- 30 BP
Beta - 363382 SAMPLE : 5006-GS103 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1520 to 1560 (Cal BP 420 to 390) AND Cal AD 1630 to 1670 (Cal BP 320 to 280) Cal AD 1780 to 1800 (Cal BP 170 to 150) AND Cal AD 1950 to 1950 (Cal BP 0 to 0)	250 +/- 30 BP	-24.6 o/oo	260 +/- 30 BP
Beta - 363383 SAMPLE : 8004GS110 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1650 to 1690 (Cal BP 300 to 260) AND Cal AD 1730 to 1810 (Cal BP 220 to 140) Cal AD 1920 to post 1950 (Cal BP 30 to post 1950)	180 +/- 30 BP	-24.1 o/oo	190 +/- 30 BP
Beta - 363384 SAMPLE : 8006-GS111 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1710 to 1720 (Cal BP 240 to 230) AND Cal AD 1830 (Cal BP 120) Cal AD 1890 to 1910 (Cal BP 60 to 40) AND Cal AD post 1950	10 +/- 30 BP	-23.0 o/oo	40 +/- 30 BP

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the <sup>14</sup>C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby <sup>14</sup>C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured <sup>13</sup>C/<sup>12</sup>C ratios (delta <sup>13</sup>C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta <sup>13</sup>C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta <sup>13</sup>C, the ratio and the Conventional Radiocarbon Age will be followed by "\*\*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

# CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-22.8:lab. mult=1)

**Laboratory number: Beta-363381**

**Conventional radiocarbon age: 250±30 BP**

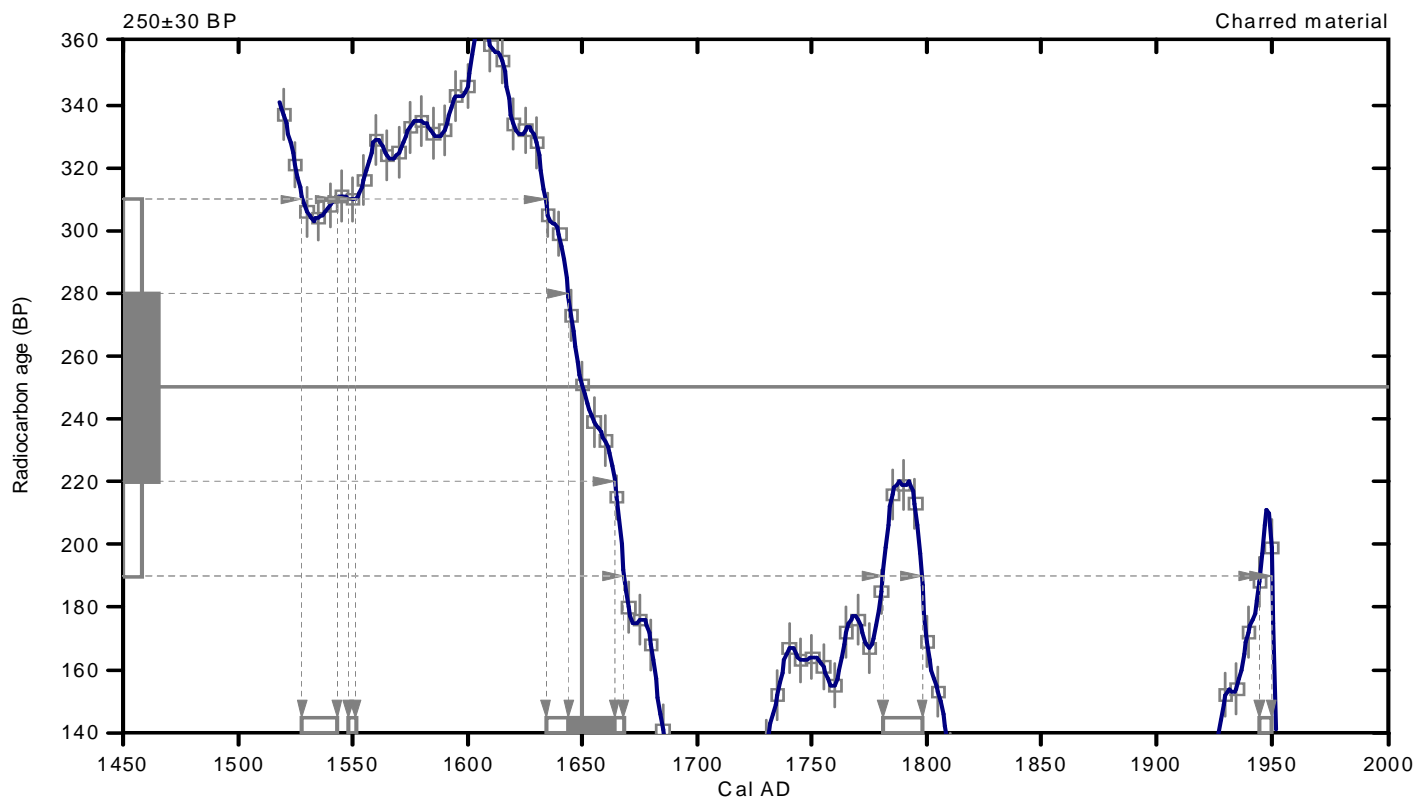
**2 Sigma calibrated results: Cal AD 1530 to 1540 (Cal BP 420 to 410) and  
(95% probability) Cal AD 1550 to 1550 (Cal BP 400 to 400) and  
Cal AD 1630 to 1670 (Cal BP 320 to 280) and  
Cal AD 1780 to 1800 (Cal BP 170 to 150) and  
Cal AD 1940 to 1950 (Cal BP 0 to 0)**

Intercept data

Intercept of radiocarbon age

with calibration curve: Cal AD 1650 (Cal BP 300)

**1 Sigma calibrated result: Cal AD 1640 to 1660 (Cal BP 310 to 290)  
(68% probability)**



## References:

*Database used*  
INTCAL09

### References to INTCAL09 database

Heaton, et.al., 2009, Radiocarbon 51(4):1151-1164, Reimer, et.al., 2009, Radiocarbon 51(4):1111-1150, Stuiver, et.al., 1993, Radiocarbon 35(1):137-189, Oeschger, et.al., 1975, Tellus 27:168-192

### Mathematics used for calibration scenario

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2):317-322

## Beta Analytic Radiocarbon Dating Laboratory

4985 S.W. 74th Court, Miami, Florida 33155 • Tel: (305)667-5167 • Fax: (305)663-0964 • E-Mail: beta@radiocarbon.com

# CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.6:lab. mult=1)

**Laboratory number: Beta-363382**

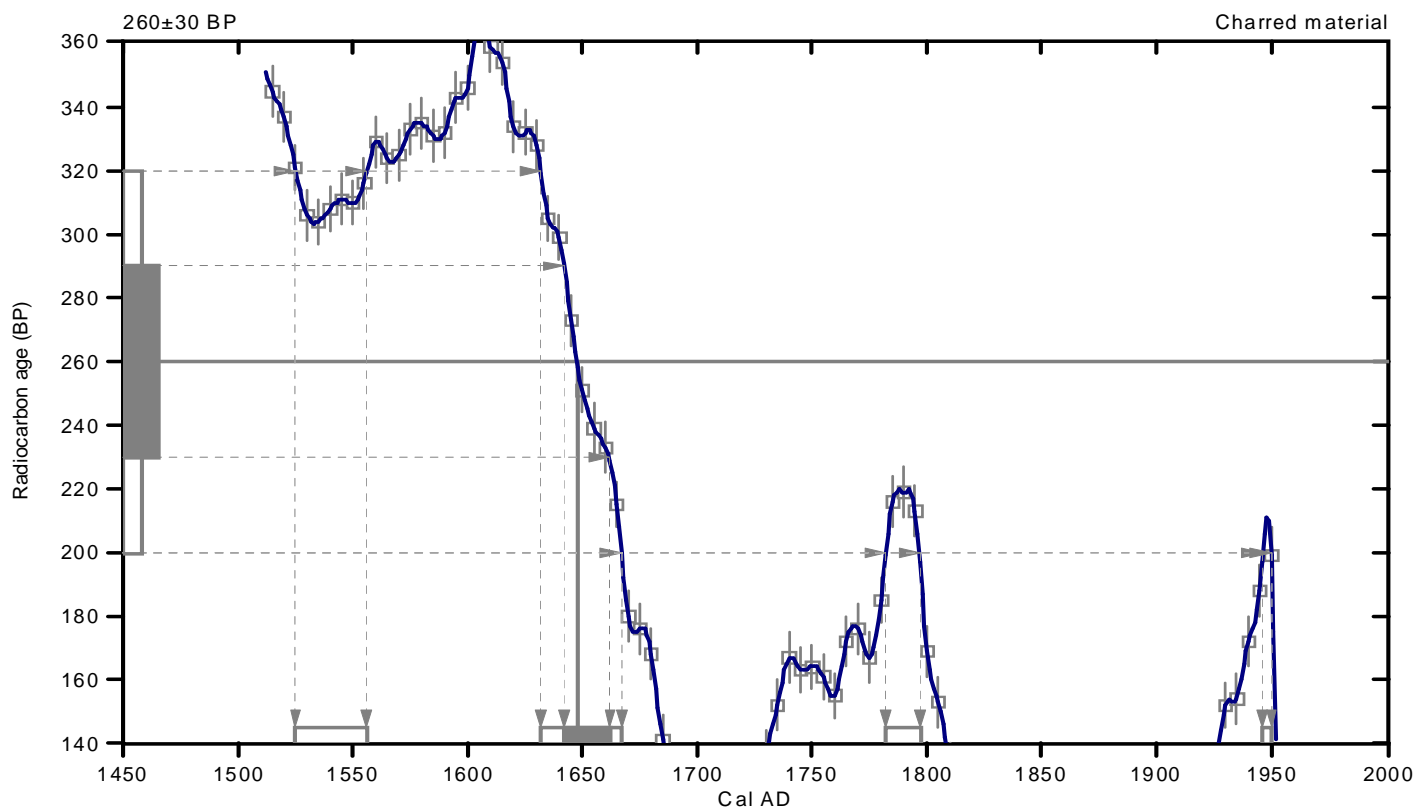
**Conventional radiocarbon age: 260±30 BP**

**2 Sigma calibrated results: Cal AD 1520 to 1560 (Cal BP 420 to 390) and  
(95% probability) Cal AD 1630 to 1670 (Cal BP 320 to 280) and  
Cal AD 1780 to 1800 (Cal BP 170 to 150) and  
Cal AD 1950 to 1950 (Cal BP 0 to 0)**

Intercept data

Intercept of radiocarbon age  
with calibration curve: Cal AD 1650 (Cal BP 300)

1 Sigma calibrated result: Cal AD 1640 to 1660 (Cal BP 310 to 290)  
(68% probability)



## References:

*Database used*  
INTCAL09

### References to INTCAL09 database

Heaton, et.al., 2009, *Radiocarbon* 51(4):1151-1164, Reimer, et.al., 2009, *Radiocarbon* 51(4):1111-1150, Stuiver, et.al., 1993, *Radiocarbon* 35(1):137-189, Oeschger, et.al., 1975, *Tellus* 27:168-192

### Mathematics used for calibration scenario

*A Simplified Approach to Calibrating C14 Dates*

Talma, A. S., Vogel, J. C., 1993, *Radiocarbon* 35(2):317-322

## Beta Analytic Radiocarbon Dating Laboratory

4985 S.W. 74th Court, Miami, Florida 33155 • Tel: (305)667-5167 • Fax: (305)663-0964 • E-Mail: beta@radiocarbon.com

# CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.1:lab. mult=1)

**Laboratory number: Beta-363383**

**Conventional radiocarbon age: 190±30 BP**

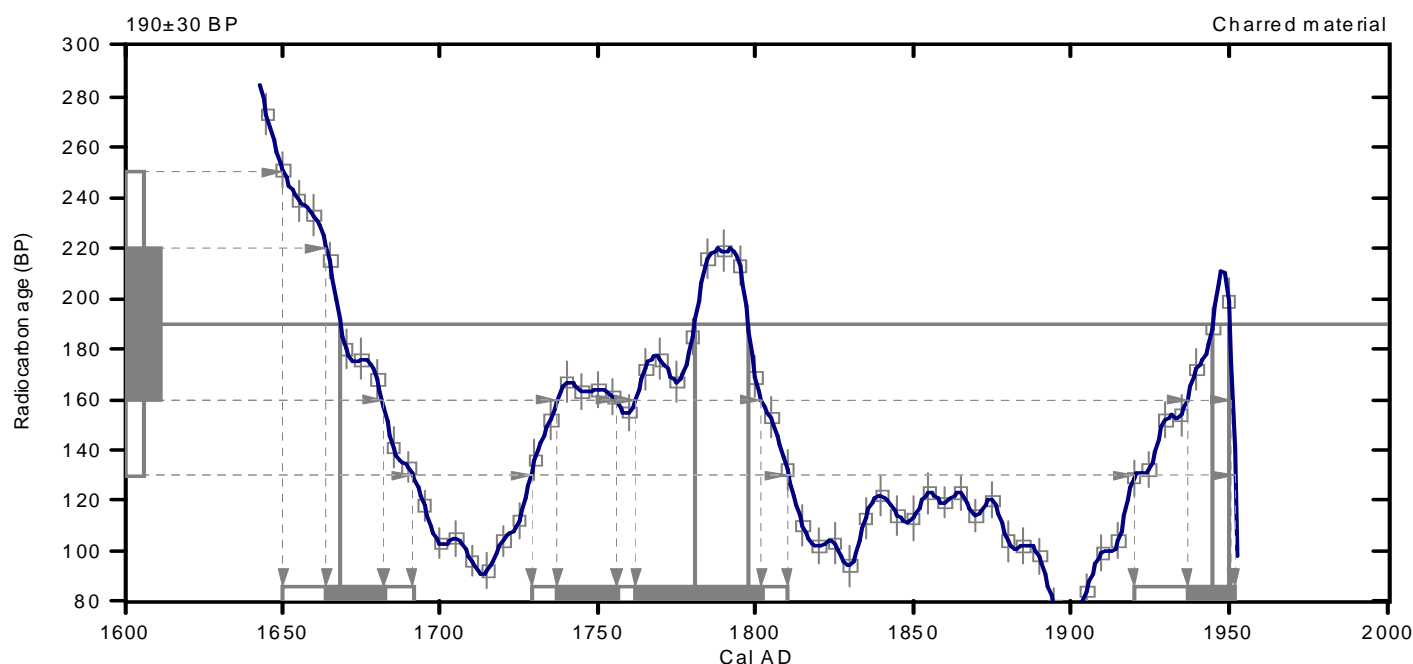
**2 Sigma calibrated results: Cal AD 1650 to 1690 (Cal BP 300 to 260) and  
(95% probability) Cal AD 1730 to 1810 (Cal BP 220 to 140) and  
Cal AD 1920 to post 1950 (Cal BP 30 to post 1950)**

Intercept data

Intercepts of radiocarbon age  
with calibration curve:

Cal AD 1670 (Cal BP 280) and  
Cal AD 1780 (Cal BP 170) and  
Cal AD 1800 (Cal BP 150) and  
Cal AD 1940 (Cal BP 0) and  
Cal AD 1950 (Cal BP 0)

**1 Sigma calibrated results: Cal AD 1660 to 1680 (Cal BP 290 to 270) and  
(68% probability) Cal AD 1740 to 1760 (Cal BP 210 to 190) and  
Cal AD 1760 to 1800 (Cal BP 190 to 150) and  
Cal AD 1940 to post 1950 (Cal BP 10 to post 1950)**



## References:

*Database used*  
INTCAL09

### References to INTCAL09 database

Heaton, et.al., 2009, *Radiocarbon* 51(4):1151-1164, Reimer, et.al., 2009, *Radiocarbon* 51(4):1111-1150,  
Stuiver, et.al., 1993, *Radiocarbon* 35(1):1-244, Oeschger, et.al., 1975, *Tellus* 27:168-192

### Mathematics used for calibration scenario

*A Simplified Approach to Calibrating C14 Dates*  
Talma, A. S., Vogel, J. C., 1993, *Radiocarbon* 35(2):317-322

## Beta Analytic Radiocarbon Dating Laboratory

4985 S.W. 74th Court, Miami, Florida 33155 • Tel: (305)667-5167 • Fax: (305)663-0964 • E-Mail: beta@radiocarbon.com

# CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23:lab. mult=1)

**Laboratory number: Beta-363384**

**Conventional radiocarbon age:  $40 \pm 30$  BP**

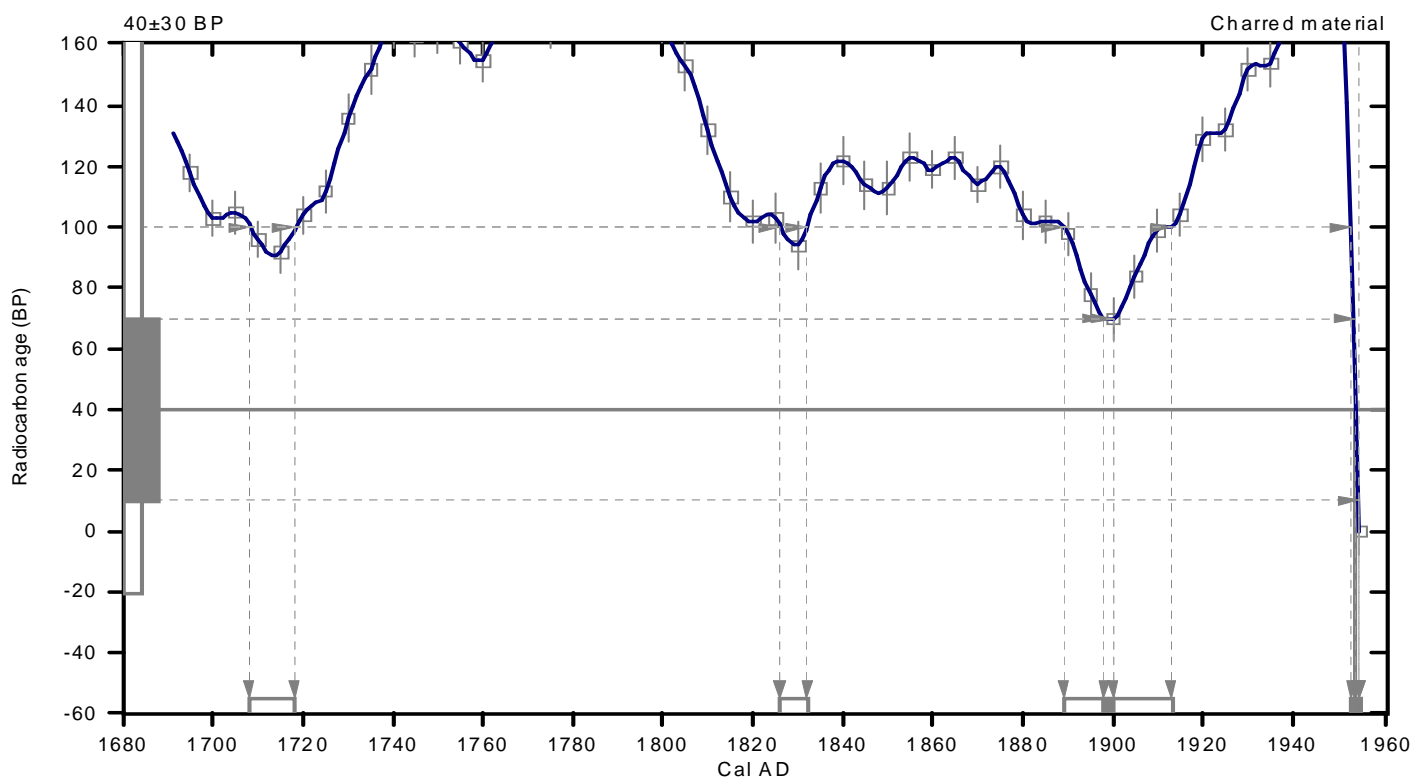
**2 Sigma calibrated results<sup>2</sup>: Cal AD 1710 to 1720 (Cal BP 240 to 230) and  
(95% probability) Cal AD 1830 to 1830 (Cal BP 120 to 120) and  
Cal AD 1890 to 1910 (Cal BP 60 to 40) and  
Cal AD Post 1950**

<sup>2</sup> 2 Sigma range being quoted is the maximum antiquity based on the minus 2 Sigma range

## Intercept data

Intercept of radiocarbon age  
with calibration curve: Cal AD Post 1950

1 Sigma calibrated results: Cal AD 1900 to 1900 (Cal BP 50 to 50) and  
(68% probability) Cal AD Post 1950



## References:

*Database used*

INTCAL09

*References to INTCAL09 database*

Heaton, et.al., 2009, *Radiocarbon* 51(4):1151-1164, Reimer, et.al., 2009, *Radiocarbon* 51(4):1111-1150, Stuiver, et.al., 1993, *Radiocarbon* 35(1):1-244, Oeschger, et.al., 1975, *Tellus* 27:168-192

*Mathematics used for calibration scenario*

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, *Radiocarbon* 35(2):317-322

## Beta Analytic Radiocarbon Dating Laboratory

4985 S.W. 74th Court, Miami, Florida 33155 • Tel: (305)667-5167 • Fax: (305)663-0964 • E-Mail: beta@radiocarbon.com

## **Appendix C**

### **USLE Calculations**

USLE equation and calculations used in this thesis, referenced particularly in Chapter 5. All USLE equations use Hurni's (1985) calibrations for Ethiopia (Table C.1). The value for R ( $R = 498$ ) is based on the median average rainfall for the Gännäta Maryam region as discussed in Chapter 2.



Table C.1. Hans Hurni's report of *Universal Soil Loss Equation* factors calibrated for use in Ethiopia (Hurni 1985a, reproduced by Nyssen et al. 2004).

The Universal Soil Loss Equation (USLE) adapted for Ethiopia (Hurni, 1985) ( $R$  in  $J\ cm\ m^{-2}\ h^{-1}\ year^{-1}$ ,  $K$  also in SI units, following Wischmeier and Smith's (1978) conversion coefficient)

THE UNIVERSAL SOIL LOSS EQUATION (USLE) ADAPTED FOR ETHIOPIA

SOURCE: WISCHMEIER AND SMITH, 1978

ADAPTIONS: R CORRELATION: HURNI, 1985

K VALUES: FROM BONO AND SEILER, 1983, 1984; AND WEIGEL, 1985

S EXTRAPOLATION: HURNI, 1982

EQUATION:  $A = R * K * L * S * C * P$  (TONS PER HA PER YR)

1. R: RAINFALL EROSIVITY

ANNUAL RAINFALL (MM)	100	200	400	800	1200	1600	2000	2400
ANNUAL FACTOR R	48	104	217	441	666	890	1115	1340

2. K: SOIL ERODIBILITY

SOIL COLOUR	BLACK	BROWN	RED	YELLOW
FACTOR K	0.15	0.20	0.25	0.30

3. L: SLOPE LENGTH

LENGTH (M)	5	10	20	40	80	160	240	320
FACTOR L	0.5	0.7	1.0	1.4	1.9	2.7	3.2	3.8

4. S: SLOPE GRADIENT

SLOPE (%)	5	10	15	20	30	40	50	60
FACTOR S	0.4	1.0	1.6	2.2	3.0	3.8	4.3	4.8

5. C: LAND COVER

DENSE FOREST:	0.001	DENSE GRASS:	0.01
OTHER FOREST:	SEE GRASS	DEGRADED GRASS:	0.05
BADLANDS HARD:	0.05	FALLOW HARD:	0.05
BADLANDS SOFT:	0.40	FALLOW PLOUGHED:	0.60
SORGHUM, MAIZE:	0.10	ETHIOPIAN TEF:	0.25
CEREALS, PULSES:	0.15	CONTINUOUS FALLOW:	1.00

6. P: MANAGEMENT FACTOR

PLOUGHING UP AND DOWN:	1.00	PLOUGHING ON CONTOUR:	0.90
STRIP CROPPING:	0.80	INTERCROPPING:	0.80
APPLYING MULCH:	0.60	DENSE INTERCROPPING:	0.70
STONE COVER 80%:	0.50		
STONE COVER 40%:	0.80		

Estimated soil loss rate from the slopes of Kiflie Mado:

$$A = 498 * 0.2 * 0.62 * 1 * 0.25 * 0.9 = 13.89\ t\ ha^{-1}$$

Estimated soil loss rate from the Gännäta Maryam Cemetery:

$$A = 498 * 0.15 * 0.68 * 1.6 * 0.01 * 0.5 = 0.406\ t\ ha^{-1}$$

Estimated soil loss rate from Vertisol slopes (with vegetation cover):

$$A = 498 * 0.15 * 1.9 * 0.39 * 0.15 * 0.9 = 7.47\ t\ ha^{-1}$$

Estimated soil loss rate from Vertisol slopes (with plowed, fallow surface):

$$A = 498 * 0.15 * 1.9 * 0.39 * 0.6 * 0.9 = 29.89\ t\ ha^{-1}$$

## **Appendix D**

### **Faunal Inventory**

The following is a preliminary description of faunal remains from the excavation units at Gännäta Maryam provided by Dr. Christopher Tribe of Cambridge University, England. As previously noted, Units 4 and 5 were excavated on Tarla Terrara. The former includes the two large pit features, loci.... A bag of large bones from locus 4008, the upper half of the larger of the two pit features was accidentally overlooked during the first cursory analysis and not examined in time for this thesis. Unit 6 was the ash heap at Kiflie Mado. The loci here were arbitrarily determined in the ash feature as there was no discernible stratigraphy. I have suggested that some of the avian bones reminiscent of chicken, if they are not in fact domesticated chicken, may be indigenous wild francolin (*Francolinus* sp.). In 2009 farmers in Mezber, Tigray, told me francolin were occasionally trapped for food.

Table D.1. Location, quantity, and preliminary description of faunal remains recovered from excavations.

Locus	Items in sample	Description
[4001]	1	Fragment of unidentified mammalian long bone, perhaps young sheep radius
[4002]	18	Fragments of sheep (?) rib and long bone
[4003]	1	Fragment of unidentified mammalian trabecular bone
[4003]	1	Fragment of unidentified long bone, perhaps sheep or even cow
[4005]	17	Nearly intact sheep-sized rib. Fowl long bones. Severely weathered, unidentifiable vertebrae (mammal or bird?). Fragments of hypsodont tooth crown (probably sheep). Possible sheep canine crown, broken (ivory white, rounded like large split barley grain)
[4006]	1	Fragment of unidentifiable trabecular bone (mammalian)
[4006]	63	Mixture of bird (chicken?) and rodent (rat-sized) bones. Bird long bones, sternum, ribs. Some small vertebrae (bird or rodent). Rodent maxilla with 2 teeth, humerus, part of pelvis, phalanx

[4007]	9	Fragments of shattered rib (sheep-sized, at least). Possibly a rodent zygomatic process
[4009]	6	Fragments of unidentified trabecular bone (mammalian).
[5001]	1	Perhaps an occipital bone from a medium-sized mammal.
[5001]	16	Fragments of unidentified large-mammal bone. Hypsodont selenodont tooth (probably sheep), plus some tooth fragments.
[5001]	15	Fragments of hypsodont, selenodont tooth (sheep?). Fragments of sheep-sized long bone, and possibly skull fragments. Rock fragment.
[5002]	131	Fragments of large-mammal (sheep/cattle?) rib, vertebra, and unidentifiable bones
[5002]	5	1st phalanx, cattle sized. Fragment of rib from smaller mammal. Charred bone fragment
[5003]	16	Bone fragments, mammalian, some grey (charred?)
[5004]	4	Fragments of shattered rib (sheep-sized, at least)
[5006]	4	1st phalanx, cattle sized. Bird mandible.
[5008]	2	Fragments of rib? (sheep?)
[6001]	28	Fragments of unidentified mammalian cranium? Fragments of long bones (young sheep?). Fragment of hypsodont, selenodont tooth (sheep?). Rock fragment.
[6002]	98	Several sheep-sized bones: ulna, ilium (part, with knife mark), zygomatic process of squamosal, metatarsus (with cut marks and tooth marks), rib fragments (some blackened), skull bone fragments; possible charred tooth fragments, small long bone with cortical layer removed (weathered or digested?). Fowl bones: fibulae (3, so at least 2 birds), ribs, clavicle, tarsometatarsus? (crushed), terminal phalanx. Rock fragments.
[6003]	44	Bird bones, some longer and more slender than chicken: furcula, scapula, coracoid, ulna, metacarpals II & III, fibula, phalanx, vertebra; plus fragments. Mammal bones, sheep size: rib fragments (1 with cut mark), long bone fragments, skull bone fragments; incisor tooth, canine tooth (also sheep sized). Rock fragments.
[6004]	45	Bird (chicken-sized) bones: metatarsus, humeri (3), scapula, ribs, long bone fragments, ischium, part of mandible, part of sternum, part of vertebra. Cattle-sized fragment of mandible;. Sheep-sized ribs. Fragments of hypsodont, selenodont teeth (sheep?). Small unidentified pelvis. Rock fragment.
[6005]	4	Bird bones, longer and more slender than chicken: metatarsus(?), radius(?), scapula.

## **Appendix E**

### **Ceramics**

This appendix provides additional information on the ceramic assemblage not included in the main body of the thesis. While Chapter 6 provides a reasonably detailed discussion of the ceramic assemblage and its analysis germane to the thesis, this appendix provides further information on the research methods, definitions used, and a much more detailed examination and discussion of the rims intended for comparison with future ceramic research in the region. By making research terms and methods clear here, I hope to facilitate re-examination of the assemblage, and comparison to future analyses of other assemblages. The additional typological breakdown and discussion of the rim profiles is intended to give a more detailed account of their features than was provided in Chapter 6 and provide foundations, problems, and questions for the advancement of a more accurate regional typology as more and hopefully better-preserved ceramic assemblages become available.

### **Part I: Research Definitions**

#### **E. 1. Recording methods and terminology**

As one of the very few, if not the only, extensive multivariate analysis of a large collection of archaeological Ethiopian ceramics, few features and characteristics of the ceramics could be predicted prior to the commencement of recording. As such, many

methods and terms were developed in the first few hours of recording to accommodate the variety of variables encountered. Generally, I took the approach of trying to record every readily observable objective feature of the ceramics as precisely as I could practically accomplish with the idea that important, though previously unconsidered variables would not be overlooked, and variables that turned out to be of little or no diagnostic value could be passed over in subsequent discussions. In some instances, features like the presence of crystals and different colors of *geha* were recorded, only for me to learn that crystals were a by-product of the use of *geha*, and the color of *geha* is insignificant, at least to current potters. While I continued to record these features even after I learned of their probable insignificance, and in some cases attempted to look for patterns, generally there were no substantial patterns found confirming their supposed irrelevance. The following provides descriptions of the definitions and methods employed in the recording process of the ceramics for reference by future analysts of this or other assemblages.

*Size and weight.* I weighed all ceramics to a tenth of a gram and measured all ceramics with calipers to a tenth of a millimeter. For irregularly shaped ceramics like handle fragments, I often took multiple measurements; otherwise measurements were taken near the middle of the sherd or at a place that appeared to represent the average thickness. By measuring the thickness of sherds, particularly rim and diagnostic sherds, I hoped that patterns might emerge, such as a correlation between thickness and function. I hypothesized *mogogos*, for example, might have relatively standard thicknesses, which it appears after analysis that they may, while thickness may also be relative to function, water storage jars and beer pots being on average much thicker than drinking cups, for example.

*Color of the paste.* I lumped all oxidized ceramics into color classes that appeared relatively consistent and readily identifiable using their nearest values on *Munsell Soil-Color Charts* (2010; Table E.1). As with slip, *Munsell* soil color chips did not always match precisely the colors of the ceramics, particularly reds and oranges, though they were frequently close. "Dark" colors frequently appeared to be poorly oxidized variants of the similar lighter colored pastes. In Aksumite collections, there appears to be some correlation between paste color, vessel form, and temporal period

(Wilding and Munro-Hay 1989: 235), though ultimately, there appeared to be few similar correlations here.

Table E.1. Paste colors by recorded name and associated *Munsell Soil-Color Charts* (2010) value. Color values did not always match precisely. Reds/pinks in particular do not correspond precisely to available *Munsell* chips.

Recorded color name	Nearest approximate <i>Munsell</i> values
Brown	5YR 5/6-8, 5YR 4/6; 7.5YR 6/6-8, 7.5YR 5/6-8, 7.5YR 4/4-6; 10YR 6/6-8, 10YR 5/6-8, 10YR 4/4-6
Dark Brown	7.5YR 3/3-4, 7.5YR 2.5/3; 10YR 3/2-6
Black	(fully reduced)
Grey	10YR 8-5/1
Red	10R 4/8; 2.5YR 5/8, 2.5YR 4/6-8
Dark Red	7.5R 3/8; 10R 3/6; 2.5YR 3/4-6
Pink	7.5R 6-5/8; 10R6-5/8

*Firing.* Using a freshly broken edge as often as possible, I recorded the pattern of oxidation and/or reduction in the profile of the sherd. I also noted whether the boundary between an oxidized or reduced area was discrete or not, and whether a surface was only superficially oxidized or reduced. While features of oxidation and reduction in a ceramic body can tell much about the ceramic's firing environment, I did not believe such patterns were generally important in the Gännätä Maryam assemblage. Indeed, after the analysis, with the possible exception of Fine Red Wares, firing appears to have been fairly haphazard and inconsequential beyond the production of an oxidized or reduced exterior.

*Sherd type.* When the sherd was part of a particular aspect of a vessel body such as a foot or neck, a particularly distinguishable type of sherd such as a *mogogo* or "sieve," or slated for additional recording, such as a rim, it was noted. This was done not only to systematically record certain types of sherds, but also to aid in sorting and retrieving particular records for further analysis in Microsoft *Access* following initial recording. The distinguished "Fine Red Ware" ceramics, for example, stood out in the assemblage and were recorded here in order to readily find all records of them later.

*Inclusions.* Non-plastic inclusions (NPI) for all ceramics were noted (Table E.2). As best as possible under low magnification, the angularity of the inclusions was also described as "angular," "subangular," or "rounded." The average size range of the inclusions was also recorded (Table E.3). The percentage of each NPI type visible in the broken sherd edge was also estimated using a particle frequency diagram designed for the

purpose (Figure E.1; Rice 1987: 349, Figure 12.2). In addition to the percentages visualized on the diagram, I recorded intermediate ranges like "5-10%" when the percentage appeared to fall between either terminus. NPIs of all types, tempers and non-tempers, their size, volume, and angularity are all expected to be important attributes related to things like vessel function, temper source, and preparation.

Table E.2. Non-plastic inclusions identified and recorded in the assemblage. Inclusions marked with a \* were later determined to originate from *geha* temper. Those marked with a † likewise probably originate from alluvial sand temper.

Recorded non-plastic inclusions	description
h- <i>geha</i>	<i>Geha</i> in buff colors. The "h" was for use in short-hand recording for <i>geha</i> so as not to be confused with <i>grog</i>
red <i>geha</i> *	<i>Geha</i> with a reddish hue
grey <i>geha</i> *	<i>Geha</i> with a grey hue
RG <i>geha</i> *	A mixture of light red and pale green or grey-green <i>geha</i>
Brown <i>geha</i> *	<i>Geha</i> in a brown color similar to brown temper. May have been <i>grog</i> misidentified as <i>geha</i> in some instances, see discussion of temper analysis below.
crystal*	Narrow, linear crystals, possibly of quartz, later learned to derive from <i>geha</i>
sand, black	Primarily black mafic sands, later learned to be primarily a temper gathered from alluvial sources
stone <sup>†</sup>	Any of a number of small, infrequently encountered rock fragments, described in greater detail in the notes. Later hypothesized to originate in sand temper
Fe nodules <sup>†</sup>	Oxidized metallic nodules, later hypothesized to originate in sand temper
Black stone <sup>†</sup>	Small fragments of a black stone, sometimes with very fine white mottling. Later hypothesized to originate from sand temper.
<i>grog</i>	Pulvarized ceramic sherds
mica	Flecks of micaceous material, usually brown to golden, or dark red
voids	Voids. Frequently too small to discern origin, though occasional shape or striations suggest plant remains

Table E.3. Size ranges for categories of tempers. "0" was used as shorthand for >0.5, or roughly any size range smaller than was easily distinguishable with low magnification.

Size ranges for categories of tempers
>0.5 mm
0-1 mm
0-2 mm
0-3 mm
1-2 mm
1-3 mm
1-4 mm
2-3 mm

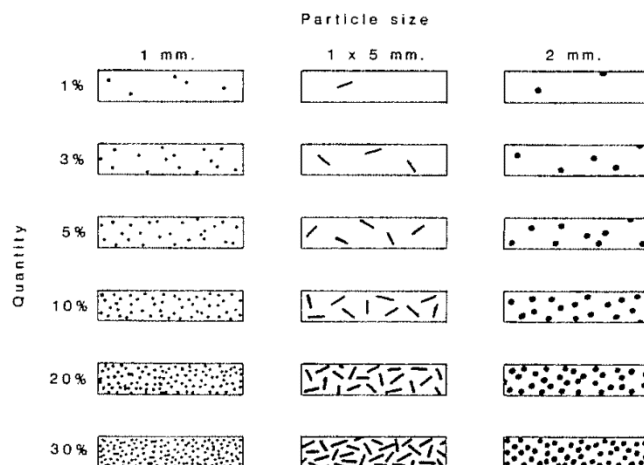


Figure 12.2 Comparison chart for estimating various quantities of different sizes and shapes of particles in a sherd cross section.

Figure E.1. Particle frequency chart used for evaluating percentage of temper in ceramic body (from Rice 1987: 349).

*Surface treatments and plastic decorations.* Each type of surface treatment or decoration I encountered was named and recorded (Table E.4). The location of the decoration was also recorded (Table E.5) and illustrated or photographed. For slip, I recorded the color similar to how paste color was recorded (Table E.6). Like paste color, some slip colors, particularly shades of red, do not match *Munsell* (2010) values precisely, but are closest matches. Generally, closest matched *Munsell* (2010) values for slip color were identical to the same-named paste colors, except for reds and oranges which were generally of a higher chroma and value than pastes and their *Munsell* (2010) values. Brown slips were often the same or very similar to the paste over which they had been applied, suggesting they may have been produced from the same clay.



Table E.4. Decorative techniques recorded in the Gännätä Maryam assemblage and their description.

Recorded term	Description
Burnished	The vessel had been burnished to a smooth finish
Slipped	The vessel had been slipped
Slipped and burnished	The vessel had been slipped and burnished
Sgraffito	The surface had been inscribed with a design after complete drying or firing, resulting in a characteristic rough incision, often with chipped edges.
Incised	The surface had been inscribed with a design while the clay was wet or leather hard
Eroded	The surface was too abraded to see the original surface
Cut	Clay had been cut away, producing characteristic rasping marks where NPIs were dragged through the surface of the clay
Smoothed	The wet clay had been smoothed by hand or "wet burnished" with an object like a piece of leather, producing an even surface, though not as smooth, or glossy, as burnishing
Rough	The vessel surface was coarser and/or more irregular than smoothed sherds, appearing as though the potter took little time to finish the surface
Broken	The surface had spalled or split off, so like eroded sherds, could not be analyzed
Punctured	One or more holes had been made through the entire ceramic profile, either pre- or post-firing. Timing of the punctures was recorded in the notes.
Punctates	One or more holes had been impressed into the clay, but did not penetrate through the profile
Fluted	Regular depressed channels or raised ridges
Crenellated	Rims or raised areas where clay had been pinched or excised, producing an alternating pattern of high and low relief
Nail impressions	One or more impressions of a fingernail
Combed	A multi-pronged implement was dragged across the surface
Twine	A piece of twine was impressed in the surface

Table E.5. Names and descriptions of the locations recorded for different decorative elements.

Recorded term	Definition
Lip	On or over the apex of the rim
Rim	Bordering the interior or exterior of the lip
Exterior body	On the exterior of a body sherd
Interior body	On the interior of a body sherd
Both sides	Both sides of a body sherd
One side	On one side of a sherd, interior or exterior indeterminate
Shoulder, above	Immediately above the shoulder
Shoulder, below	On the body immediately below the shoulder
Ridge / joint	On a ridge of clay or the joint of a body and base sherd, see analysis below for discussion of these terms
Bottom / base	On the flat or rounded bottom of a vessel

Table E.6. Slip color terms and *Munsell Soil-Color Chart* (2010) values. Red values are closest matches. Orange values are much more red-orange in value and chroma than those represented in the *Munsell* chips.

Orange	n/a (similar to, though more orange than 10R 5/8 and 2.5YR 5/8)
Red	10R 4/8; 2.5YR 5/8, 2.5YR 4/6-8
Dark Red	7.5R 3/8; 10R 3/6; 2.5YR 3/4-6
Brown	5YR 5/6-8, 5YR 4/6; 7.5YR 6/6-8, 7.5YR 5/6-8, 7.5YR 4/4-6; 10YR 6/6-8, 10YR 5/6-8, 10YR 4/4-6
Dark Brown	7.5YR 3/3-4, 7.5YR 2.5/3; 10YR 3/2-6
Black	(fully reduced)

*Rims and rim types.* I noted all rim sherds and illustrated their profiles. When possible, I also measured the internal rim diameter and its percentage of the whole. In cases where diameter of other ceramic vessel parts was determinable, such as vessel necks and foot rings, or possible tuyère pipes from Kiflie Mado, their dimensions were also recorded. I grouped and named rims by consistencies in the shape of their profile and angle (Chapter 6), though additional typological classification (below) also took into account other features.

*Additional Notes.* I also took many notes on many sherds, most in regard to features that were not readily subject to objective categorization. In most cases, I recorded additional information about other documented attributes when further explanation might have been useful for interpretation. For example, I frequently noted the state of preservation and attributes (like slip) or uncertainty about the identification of a particular attribute, such as the possibility a sherd had been cut prior to slipping and burnishing. In some instances, notes were used to describe additional features that warranted mentioning, but were not amenable to or frequent enough to warrant their own attribute category. For example, the assemblage contained a small number of sherds with charred remains on a surface. In retrospect, this could have been its own category, but since most of the sherds came from surface collections, charring was only encountered very infrequently only in preserved archaeological strata. The other most common instance was when sherds had a paste that felt or appeared intuitively different than the general assemblage, but for which no objectively discrete, categorical distinctions could be made at the time of documentation. In lieu of particular attribute categories, descriptors like "unusually -" "coarse," "gritty," "friable," "fine," or "dense" were used. In a few instances described below, these descriptors also came with a particularly

unusual paste color. Other notes included things like observations on construction technique or the possible identification of the complete vessel type.

## **Part II: Rim Types and Other Vessel Components**

### **E.2. Introduction: Rims**

Chapter 6 and Figures 6.15-18 provided a brief discussion of the variety of rim and vessel forms broken into five broad categories of rim profile. Here, those types are broken down further with consideration of additional vessel features. Though not necessarily a clear diagnostic feature indicative of vessel form or function, rims are one of the few characteristics available in this assemblage that are unique enough to help lump vessels into stylistic categories. Based on observations of contemporary ceramics and their function, I believe that rim profiles and diameters are an easily accessible means of grouping ceramics by form and function, particularly when other variables are taken into account. The typologies presented here, however, are merely speculative based on such features in this poorly-preserved assemblage, and would benefit greatly from comparison to a better-preserved assemblage where overall form, function, and associated attributes are more clearly observable. Indeed, some types appear to lack much clear patterning in attributes beside rim profile and diameter, suggesting a number of possible shortcomings of these proposed types. For example, with only incomplete rims, morphological differences in the ceramic bodies may be overlooked, attributes like paste and temper may not play a strong role in distinguishing certain types, and the unknown variability within culturally recognized vessel classes means some types may be artificially broad or narrow. The only way to resolve such problems is to identify further examples, ideally more complete than those here. This presentation then is merely speculative and is intended as a starting place for future analysis while providing further details and illustrations of rims from the assemblage.

### **E. 3. Open rims**

As a class of ceramics, the majority of these open-rimmed ceramics appear to represent bowls or basins, and perhaps some lids, varying greatly in size from 16 to 65+ cm in diameter. The majority of the sherds are burnished on the interiors and are found among both contemporary and historic wares. While all these vessels likely performed similar functions, possibly for food service or preparation given their shared attributes, with such small fragments and poor recovery contexts, it is impossible to determine if there are multiple culturally recognized functional or stylistic types represented here, or if they all represent acceptable deviations from a standard type. There may also be a chronological dimension represented in slightly modified forms or sizes, though this is impossible to determine. Other, more specialized vessel types like incense burners or fire boxes, documented in ethnographic contexts (Figures 6.3-4), may be represented, though among these fragments there was no evidence to establish such distinctions.

#### **E.3. (a) Open, rounded rims**

These vessels have simple rims with an open, gently curving profile. Differences in thickness and rim diameter, however, suggest a wide range of variation or functional differentiation. While I have separated these rims into two rim types and an intermediate type, they likely represent parts of a continuum of similarly styled, though differently sized vessels.

Type 1 rims (Figure E.2), numbering six sherds, are characterized by their relatively thin, gently curved rim profiles terminating at roughly 100° to 120°. One example, L:(8,8), is the only extant rim of a Fine Red Ware and is slightly more open than the others. Unfortunately, it was too small and eroded to evaluate things like rim diameter or surface finishes. All the rest of this assemblage have diameters ranging from 16 to 36 centimeters. Thickness is fairly constant with an average of 8.4 mm and a standard deviation of 0.95 mm. All have burnished interiors and plain or cut exteriors. Temper is variable in those that were large enough for it to be recorded. All are reduced black or oxidized brown. All these vessels were recovered from contexts such as the

*tukul* site and Kiflie Mado. Though their temper and paste do not suggest they are contemporary wares as defined previously, they may all be fairly recent relative to much of the ceramic assemblage. Without more complete vessels, determining original form and function is imprecise, though the rim profiles, finished interiors, and diameters all suggest these may represent bowls, perhaps used for preparation or serving of wet foods like stews, sauces, and porridges.

A similar type of rim (n=14; not pictured) are identical to Type 2 except all have evidence of a cut exterior just below the lip and are thicker, more in line with Type 2. While all of Type 1 came from the *tukul* survey site and Kiflie Mado, only four of these sherds come from Kiflie Mado. The rest come from a variety of surface collections around the lower terrace. There is a possibility then that the evidence for a cut or uncut exterior may be a chronological marker; it warrants repeating that in some vessels of other types smoothing or burnishing of cut surfaces was noticeable, and may have successfully obscured evidence for cutting in some vessels. Three examples from this type have diameters between 50 and 60 cm and the average thickness is a few millimeters greater than Type 1 making them more similar to Type 2; otherwise, the profiles and compositions of these are identical to Type 1. None of these differences is unexpected when considering the large sample size relative to other rim types and they are likely insignificant except to reinforce the likelihood that there may be multiple different culturally recognized vessel types or accepted deviations represented within these simple open rims.

Type 2 (Figure E.3) vessels, numbering 10 sherds, are similar to Type 1 in form, though the walls are a little thicker (avg. 12.3 mm) like the intermediate type above. Examples of this type are also found in nearly every context, rather than the limited contexts of Type 1. There is some variation in the morphology of the profile, though it is probably due to slight differences in finishing rather than an intentional or functional difference. Example L:(6,2), for example, has a unique profile, though this was probably a result of the intensive burnishing of the thickly slipped interior. The assemblage can be divided roughly into two categories based on rim diameter, those that are smaller like Type 1, ranging in the teens, and those that are larger, from 29 to 50 cm like the intermediate group. Regardless, like the Type 2s, all have relatively plain, often cut,

exteriors compared to their interiors, which are usually burnished, and little consistency in their tempering. All are reduced black or oxidized brown or red.

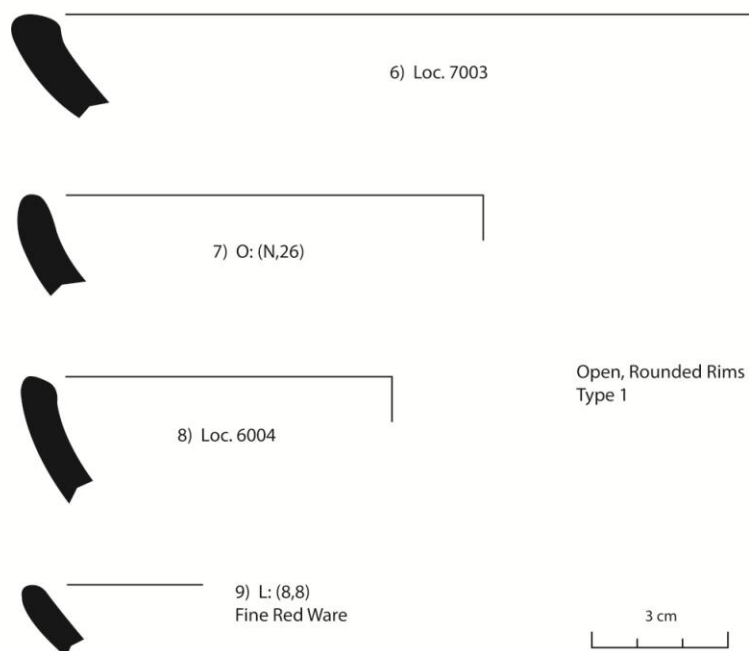


Figure E.2. Type 1 open, rounded rims.

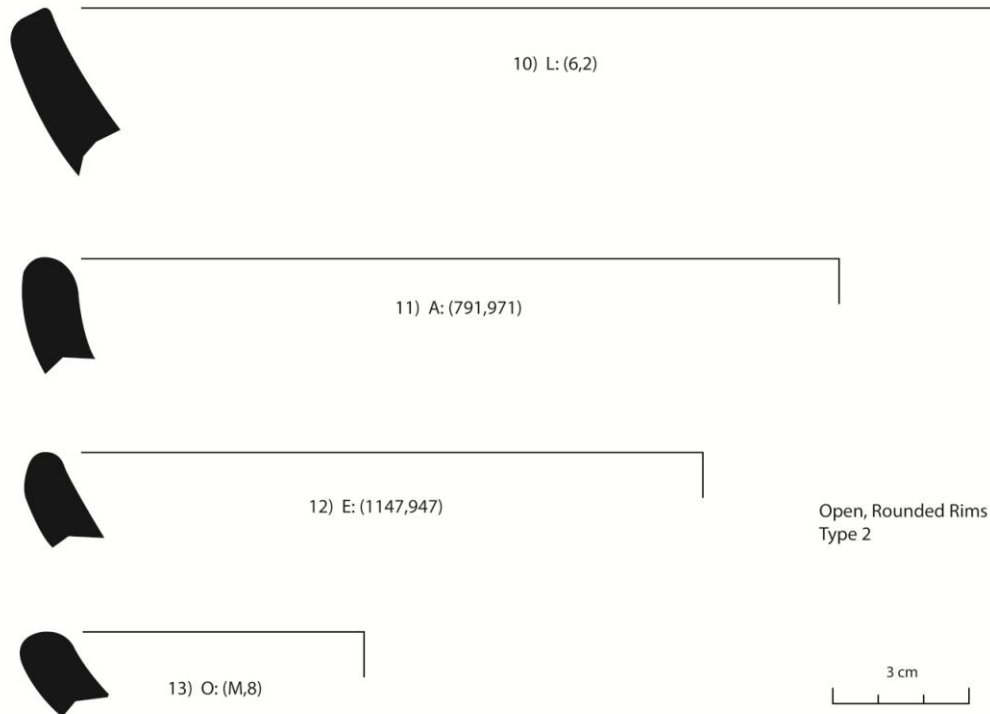


Figure E.3. Type 2 open, rounded rims.

### E.3. (b) Open, unrounded, high-angled rims

This large assortment of rims is also divided into three types by diameter, wall thickness, and manufacture, like the open, rounded rims, though they show less curvature in their profile and typically display a slightly more vertical rim, ranging between  $110^\circ$  to  $130^\circ$ .

Type 1 (Figure E.4) is the largest grouping with 30 sherds from a variety of contexts and includes both contemporary and historic wares. Type 1 sherds are distinct from Type 2 by their relative thickness, averaging 10.7 mm, and their larger diameters between 20 and 65 cm. Two of the four sherds from the *tukul* survey (collection L) contain only sand and mica as NPIs, unusual among both contemporary and historic wares. The rest of the sherds have sand and *geha* tempers, split evenly between those with more of one than another. About half have more than 5% of any given temper, though contemporary wares, which generally have a higher percentage of tempers, are all included in this. Nearly all are burnished on both the interior and exterior. Only two

examples from Unit 6 (Kiflie Mado) and one from Unit 5 (Tarla Terrara) have evidence for cut exteriors.

Type 2 rims (Figure E.5) of this class (n=6) are identical to Type 1 in terms of diameter, surface finish, temper, and other attributes. The distinction here is that these show evidence for cutting away of the base in contexts besides Units 5 and 6. In these examples it is apparent how cutting often resulted in a thinning and thus weakening of the vessel wall where the breaks occurred. It is quite possible that Type 1 all had cut bases but these segments broke away or were smoothed beyond notice.

Type 3 rims (Figure E.6), accounting for seven sherds, make up the rest of this rim type. These rims differ from Types 1 and 2 by their generally thinner walls and smaller diameters. The thickness of these sherds ranges from about 4.5 to 9.5 mm while diameters range from 8.5 to 17 cm. The sherd from I: (1191,798) has a similar profile, thickness and composition to the Fine Red Ware class of vessels and representative rim in the "Open, Rounded" category, though it is a brown paste.



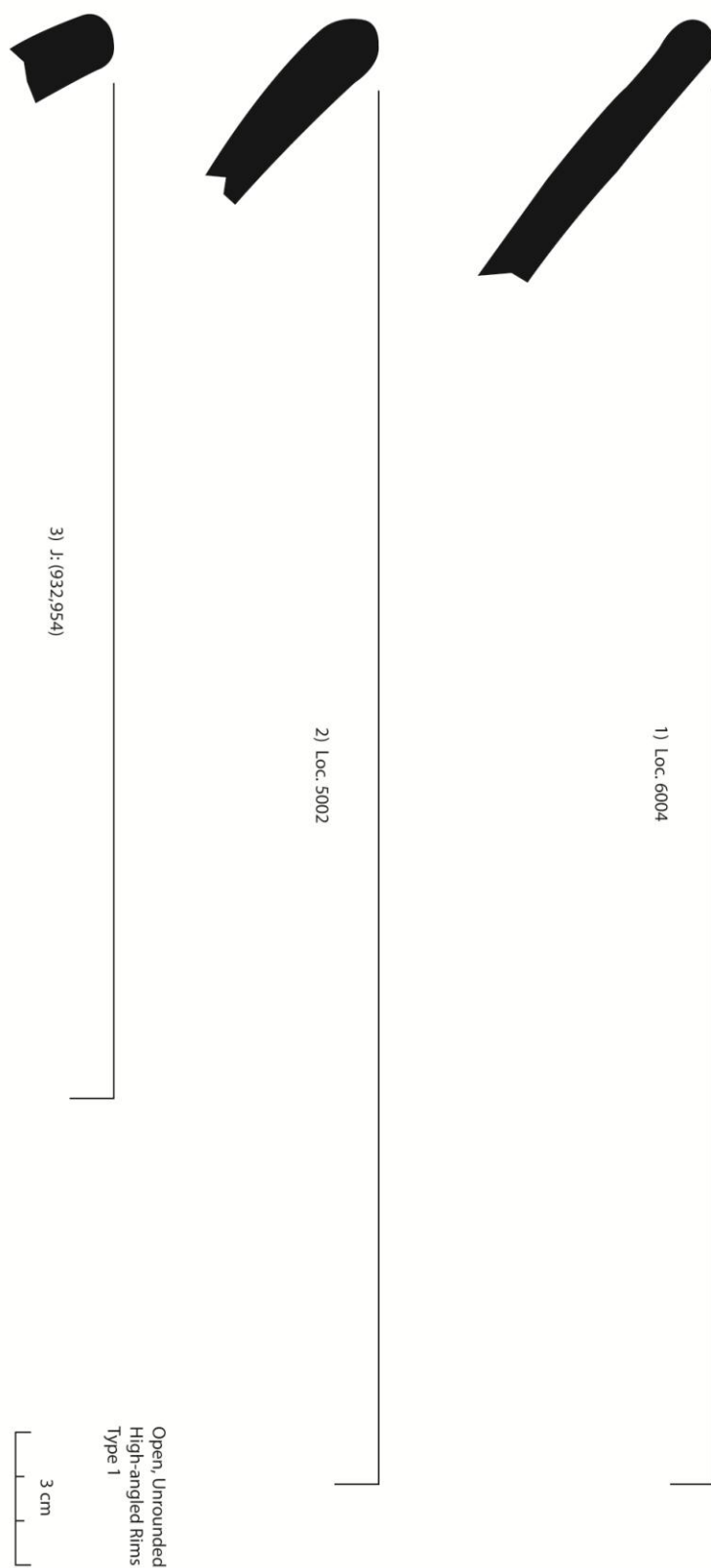


Figure E.4. Type 1 open, unrounded, high-angled rims.

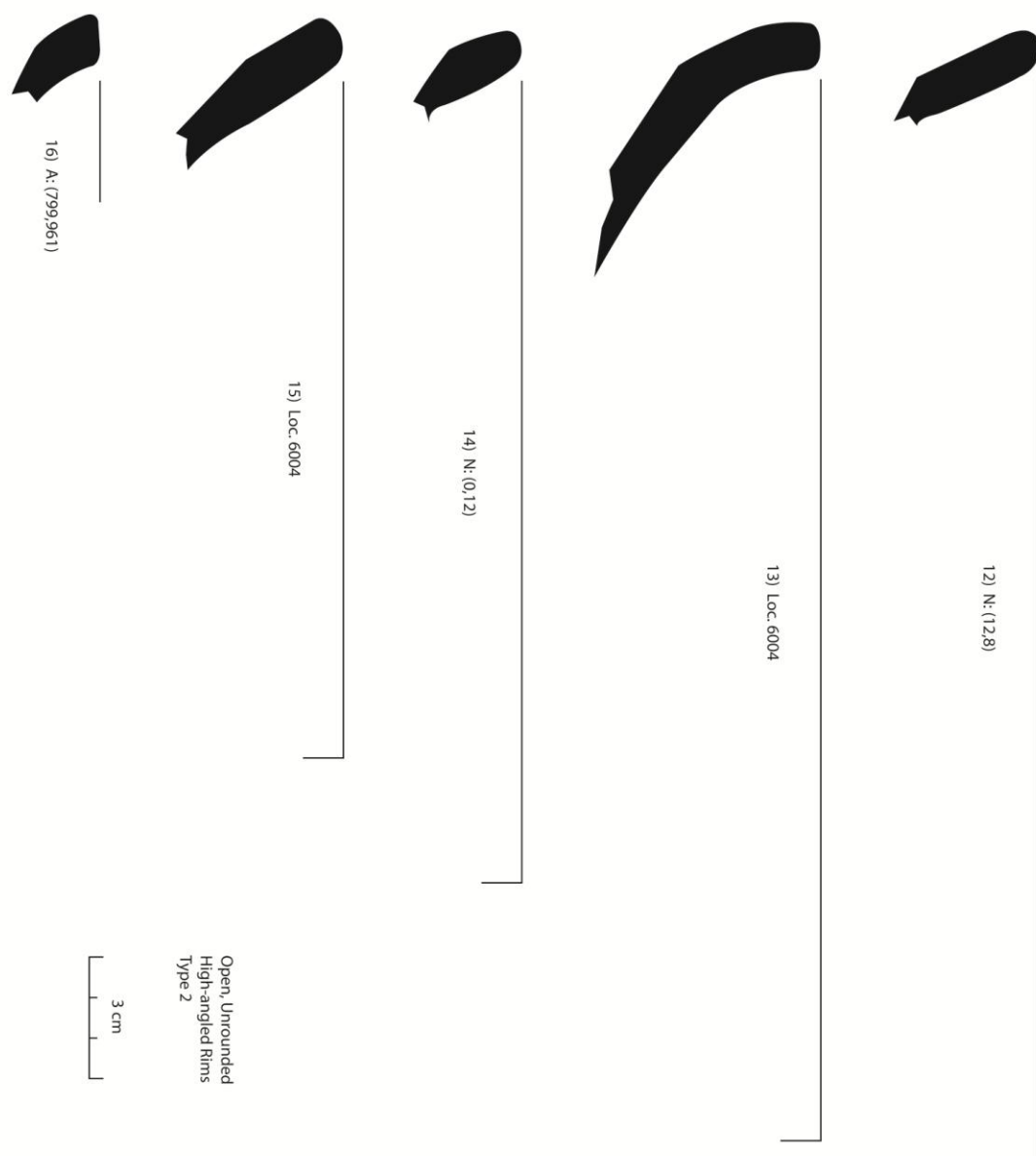


Figure E.5. Type 2 open, unrounded, high-angled rims.

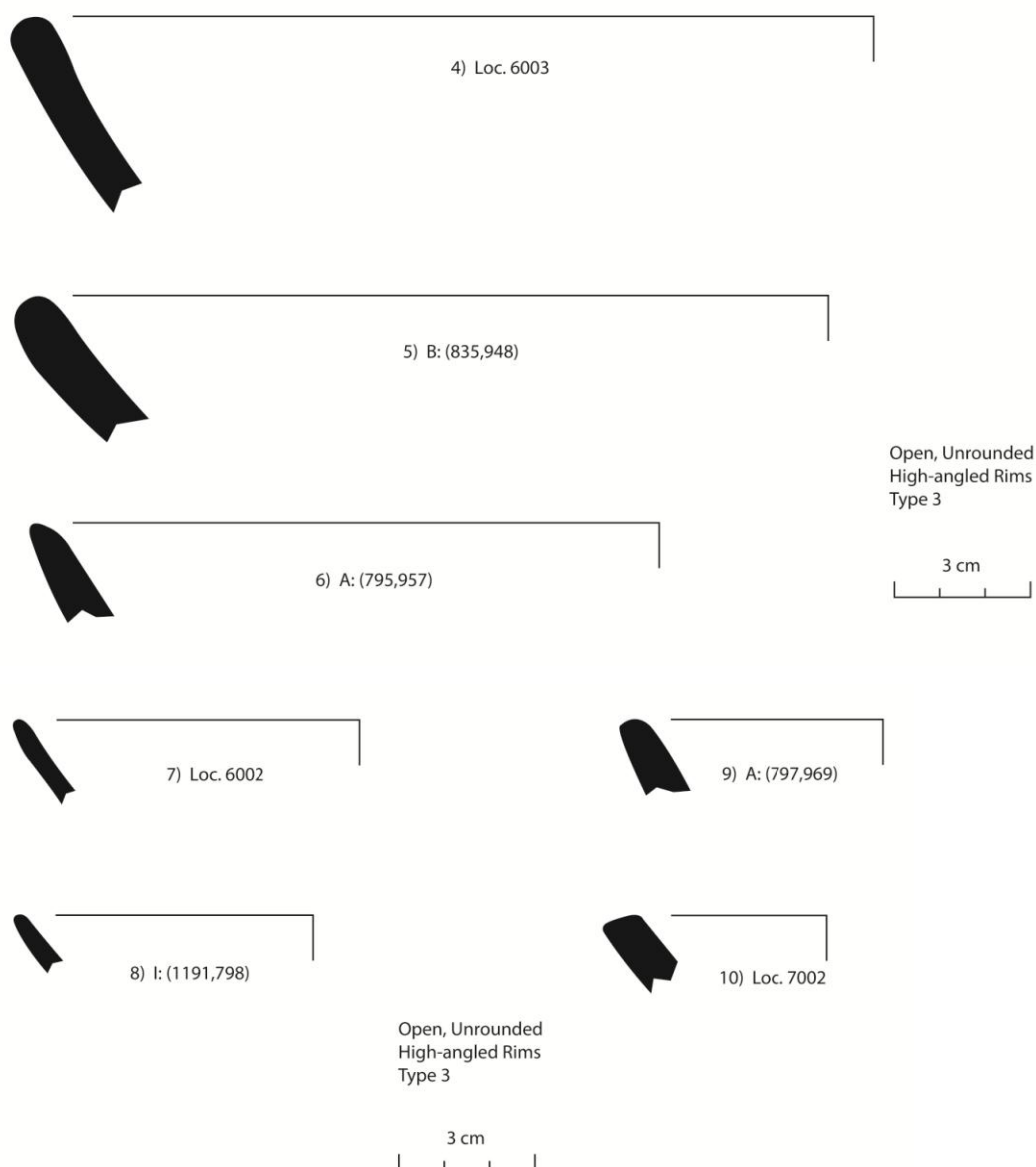


Figure E.6. Type 3 open, unrounded, high-angled rims.

### E.3. (c) Open, unrounded, low-angled rims

These 10 rims (Figures E.7-8) are characterized by their relatively straight-sided, open rims with wide open angles between  $140^{\circ}$  to  $160^{\circ}$ . These rims represent both historic and contemporary wares from Kiflie Mado, the *tukul* survey site (collection L), and surface collections A, H, and N. Rim diameter varies from 30 to 60 centimeters.

Three examples from collections H and L have only mica and sand NPIs like the examples from Type 1 of the "open, unrounded, high-angled rims," while the rest have sand and *geha* temper. All but two have an individual temper of 5% to 10%. Like all other open rims, most are burnished or wet burnished on the interior, and many on the exterior as well. A contemporary ware from the *tukul* survey has a cut underside. Initial impressions of N:(2,14), with its straight exterior lip, and H:(1242,854), with its plain interior but burnished exterior suggested to me that they may be large lids like those used today (see Figures 6.1 and 6.3). However, no other feature of lids of such size and form were recovered. Overall, these vessels, like the others, were probably plates, platters, or shallow bowls, if some were not lids.

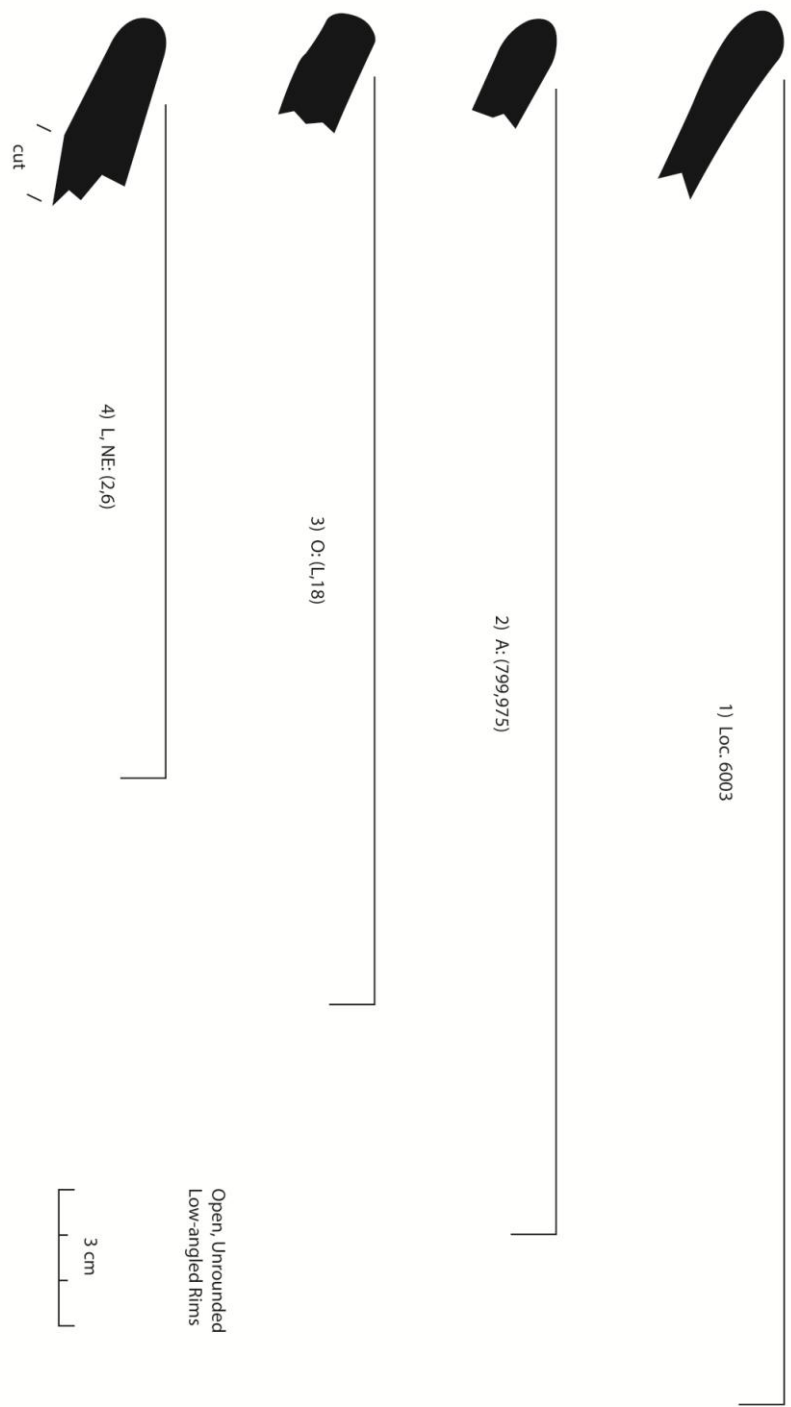


Figure E.7. Open, unrounded, low-angled rims

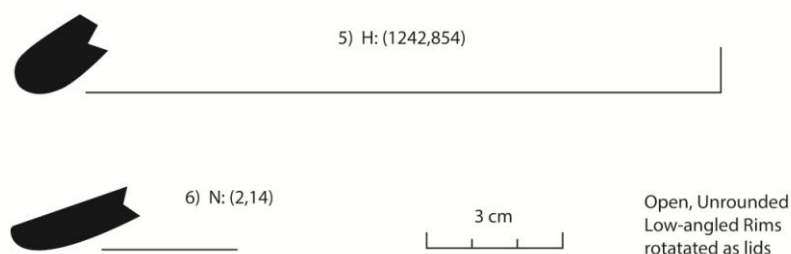


Figure E.8. Open, unrounded, low-angled rims turned over to illustrate them as possible lids.

### E.3. (d) Open, recurved rims

These three examples (only two suitable for illustration) (Figure E.9) stand out from the rest due to the slight offset in their rim profile, though they are otherwise consistent with the rest of this class by their rim angle, thickness, and diameter. It is possible this feature is merely a quirk of the potter's manufacturing process rather than an intentional distinction from other pottery types. Two came from the excavations of Tarla Terrara while the third came from Kiflie Mado. One example was burnished on both sides with a fragment of a cut, possibly rounded, base. The other two were wet burnished on both sides though not large enough to determine the appearance or treatment of the base. All have between 5-10% *geha* or sand temper. Mean vessel diameter is 41.7 cm with a standard deviation of 10 cm. Like the others, they were probably open bowls or basins.

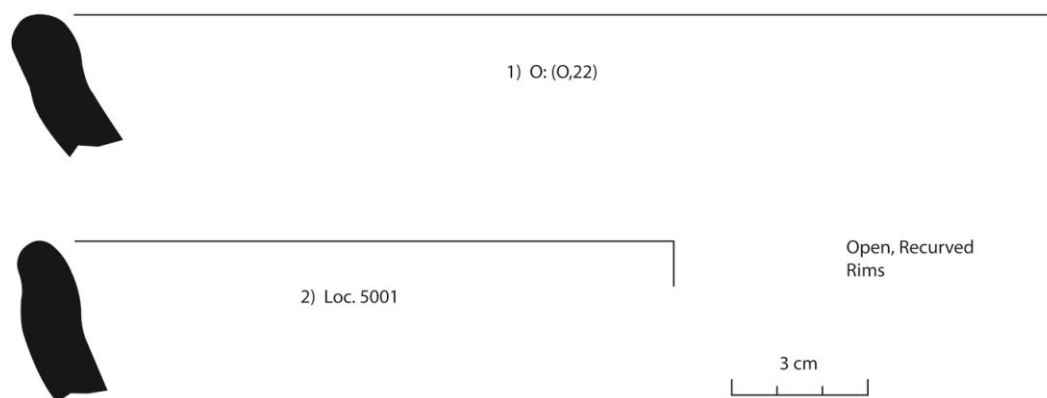


Figure E.9. Open, recurved rims.

#### E.4. Flat and shallow rims

While the rim angle, profile, and other features make some of these open vessels similar to the open vessels above, they are distinguished by their relatively shallow depth relative to their diameter, indicating that such vessels were likely wide, flat platters or plates, far shallower than those above. Some are very likely *mogogos* or other food cooking or serving surfaces. The most unique rims in this assemblage are those that are truly flat, with little or no curvature to the rim. The functions of these are unknown, though could include pot lids, bee hive covers, or some unknown vessel class.

##### E.4. (a) Shallow, upturned rims

This small class of rims (Figure E.10) is characterized by their short, often irregular or crude looking upturned rims that rise from a flattened body about the same distance as the vessel is thick. This category has been subdivided into two types based on rim diameter and vessel thickness.

Type 1 are especially large diameter rims, numbering five, though only four were subject to full analysis. They share many similarities including size, composition and surface treatments with the rims identified as *mogogos*, below, though they do not appear

as uniform or finely made. Diameters are 50, 60, and 65 cm for those that could be determined with a mean thickness of the body at 18.75 mm. Three of four have 5% sand, though one has 10% *geha*, and another has 10% *geha* but no sand, consistent with the *mogogos* and other proposed cooking vessels. Two also have burnished interiors and one a slipped and burnished interior, though the fourth is merely wet burnished, which would be uncharacteristic for a *mogogo*. Perhaps some are *mogogos* and the others not, though alternatively they may be another form of large platter, perhaps used for serving rather than cooking breads like *njera* like the ceramic platters often seen in *mesob*, traditional basketry tables for communal eating.

Type 2 are similar in form, but much thinner and significantly smaller in diameter. Of the three examples, one is 7 cm in diameter, while the others are 11 and 18. Two examples have notably tapered rims. All three are plain or wet burnished and lightly tempered with sand or *geha* at 5% or less. With so little material, it is difficult to interpret their function. The smallest of the three could be a lid (see below) or simple lamp while the others may be shallow plates not unlike those recovered at Aksum (Wilding and Munro-Hay 1989: 270, Figure 16.234) and Meshala Maryam (Chuniaud 2012: 272, Figure 9.11.3).



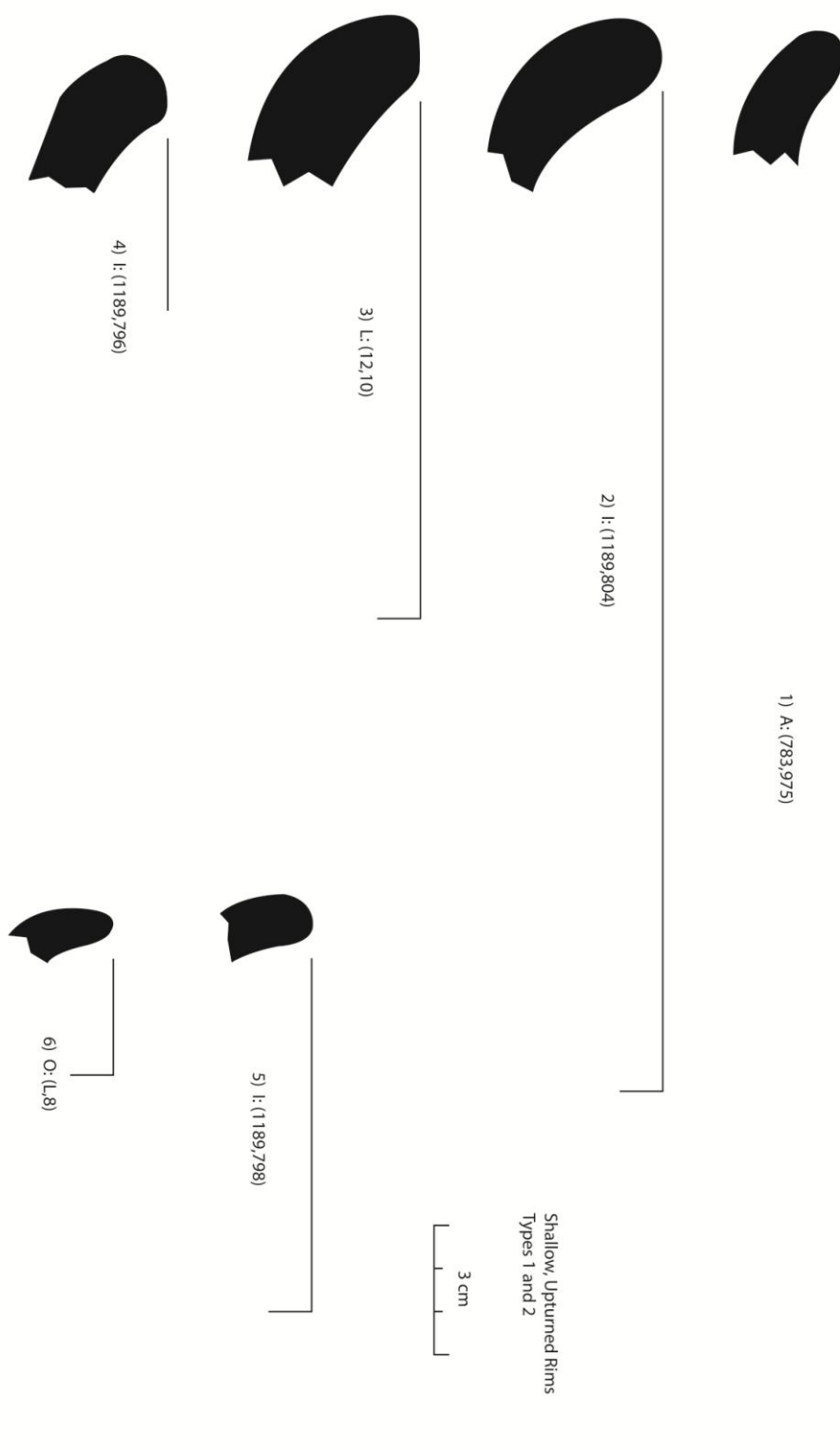


Figure E.10. Types 1 and 2 shallow, upturned rims.

#### E.4. (b) Shallow rims

These nine rims, not unlike the "shallow, upturned rims," have rather large diameters, a flat base and a short rim. Unlike the upturned rims above, however, the rims here transition smoothly into the body without an appreciable change in angle. The distance between the external side of the lip in many cases is about the same as the thickness of the body of the ceramic.

Type 1 rims (Figure E.11) all are about the same thickness (11.6 mm with a standard deviation of 1.1 mm), though their diameters vary considerably from two examples at 25 cm to one at 58 cm. Five, however, are between 30 and 40 centimeters. The ceramics were found in a variety of contexts including Unit 5, Kiflie Mado, and the *tukul* survey site. The ceramic from *tukul* survey collection L (L:(6,4)) is a contemporary ware with 10% *geha*. Sand predominates in all but one of the rest, though in very low amounts. All are burnished or wet burnished, though the contemporary one is slipped in addition. The exteriors of most are cut or are very rough. The contemporary sherd, with a 25 cm diameter, has a patina of char on the exterior. The function of these vessels is unknown, and the char may suggest a cooking function, though in form they resemble broad plates or platters.

Type 2 rims (Figure E.12) very likely represent *mogogos*, though two with a steeper angle may be large shallow basins or platters. The ceramics came from a variety of locations, including a contemporary ware from surface collection L, though most originated in excavation units 5 (Tarla Terrara), 6 and 7 (Kiflie Mado). Thickness at the lip varies, though toward the middle all average about 13 to 16 mm. All have burnished interior surfaces and cut or roughly smoothed exteriors, except one of the steeper angled rims, which is burnished on the exterior as well. One, notably, has an incised line around the interior lip. Average diameter is 48.7 cm with a standard deviation of 9.2 cm. Six sherds have 10% or close to 10% of either sand or *geha* temper, while the other two have 5%. Notably, none from Unit 5 have sand temper, which is also true of body sherds identified as *mogogos* from this locus as well, though they may all be fragments of only two vessels. Meanwhile all from surface collection L, clearly a contemporary ware, and from Unit 7 at Kiflie Mado have a high percentage of sand. While the discussion on

tempering in Chapter 6 suggests the preference for sand tempering in cooking vessels may be a modern phenomenon or one exclusive to Tsehaynesh, the presence of high sand percentages among these in the Kiflie Mado assemblage indicates this is still a question worth exploring. All ceramics were brown or red, though many were poorly oxidized and a few with superficial reduction to one or both surfaces. The rest of the ceramics with this rim type are somewhat variable in rim diameter and other attributes and may represent vessels visually similar to, though functionally distinct from *mogogos*.

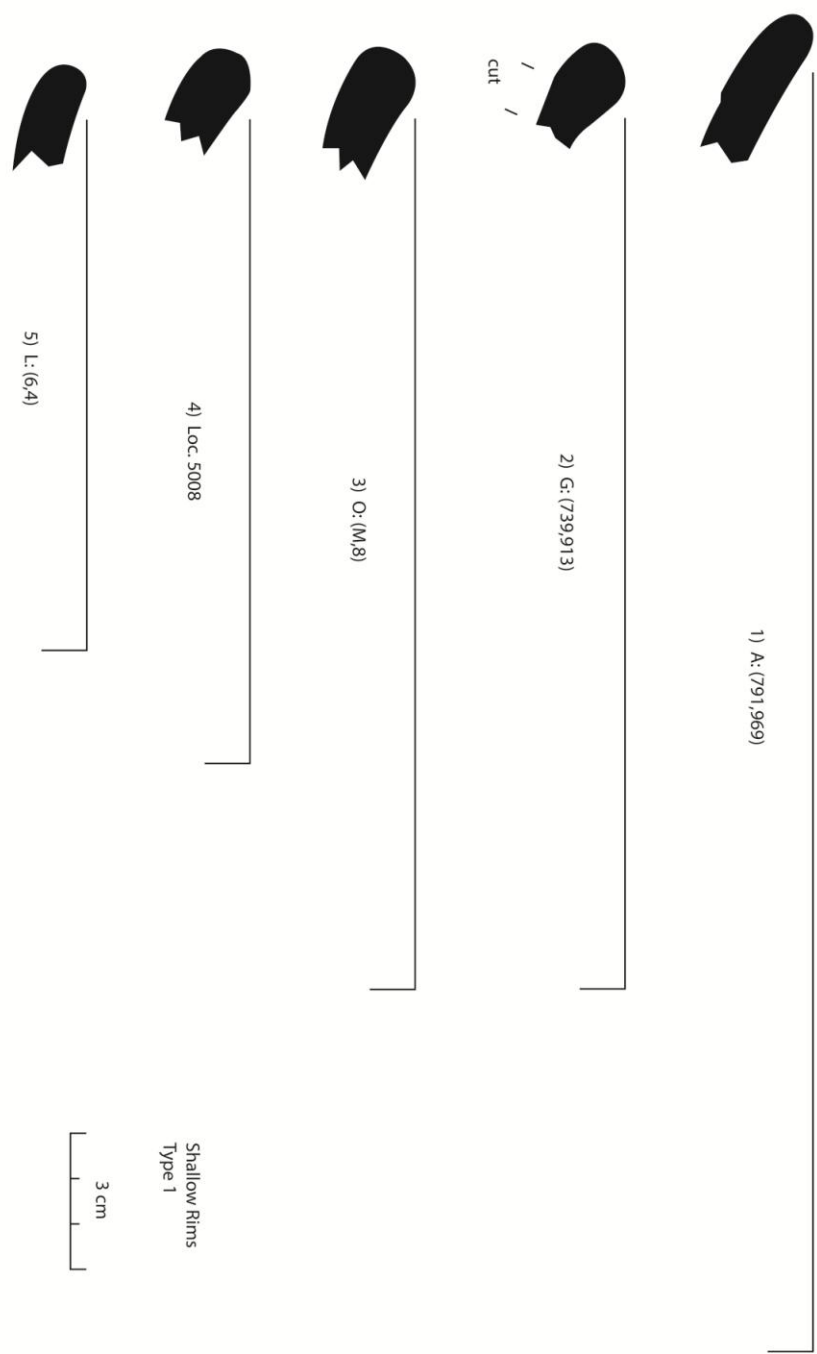


Figure E.11. Type 1 shallow rims.

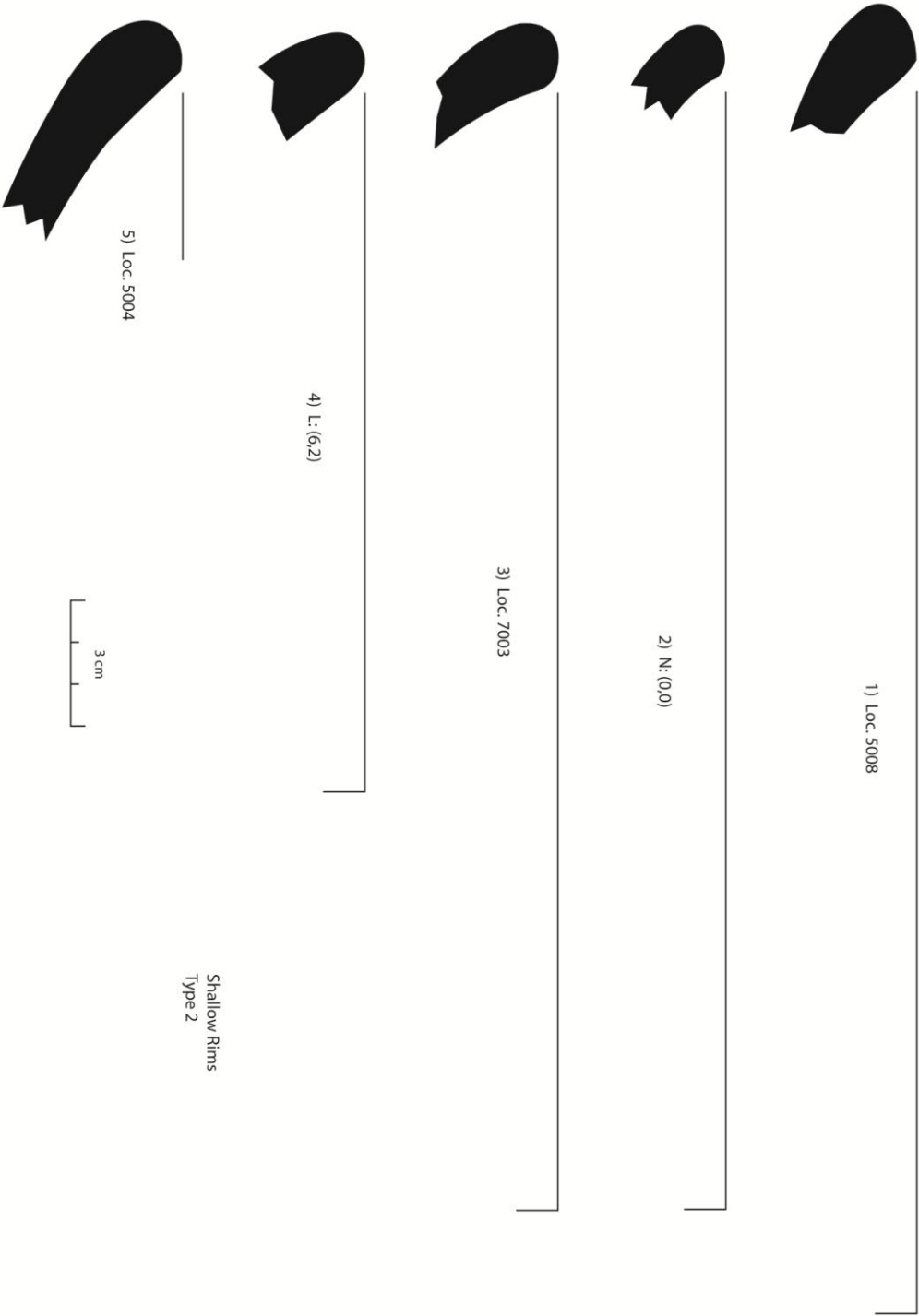


Figure E.12. Type 2 shallow rims.

#### E.4. (c) Flat rims

These five vessels (Figure E.13), all from surface collection O at Kiflie Mado are characterized by their very horizontal orientation. The functions of these vessels are unknown, though with the exception of the punctured one, they may be plates or cooking surfaces but with a rim style peculiar to the Kiflie Mado potter(s).

Vessel O:(K,12) has one level surface smoothed while forming and an uneven, cut surface. The ceramic contains *geha* temper, but no sand. The diameter was likely greater than 30 cm, but is indeterminate. Along the break, there is evidence for a small hole made prior to firing. This may be a rim fragment of the "seives" discussed in Chapter 6 potentially used in bee keeping.

Vessels O:(M,6.1) and O:(M6.2) are similar in thickness, though O:(M,6.1) has a slightly bulging rim profile similar to the larger sherd, O:(N,22). O:(M,6.2) and O:(N,22) are both tempered with sand and *geha* in roughly equal amounts. All three of the sherds have burnished surfaces and rough or cut undersides. Their diameter could not be determined.

Vessel O:M,22 is about 32 cm in diameter and still possesses charring on the exterior of the rim. Unlike the rest, the lip of this one does rise above the surface slightly. Like the others in this class, it is lightly tempered with roughly equal amounts of sand and *geha*. It was wet burnished on both sides.

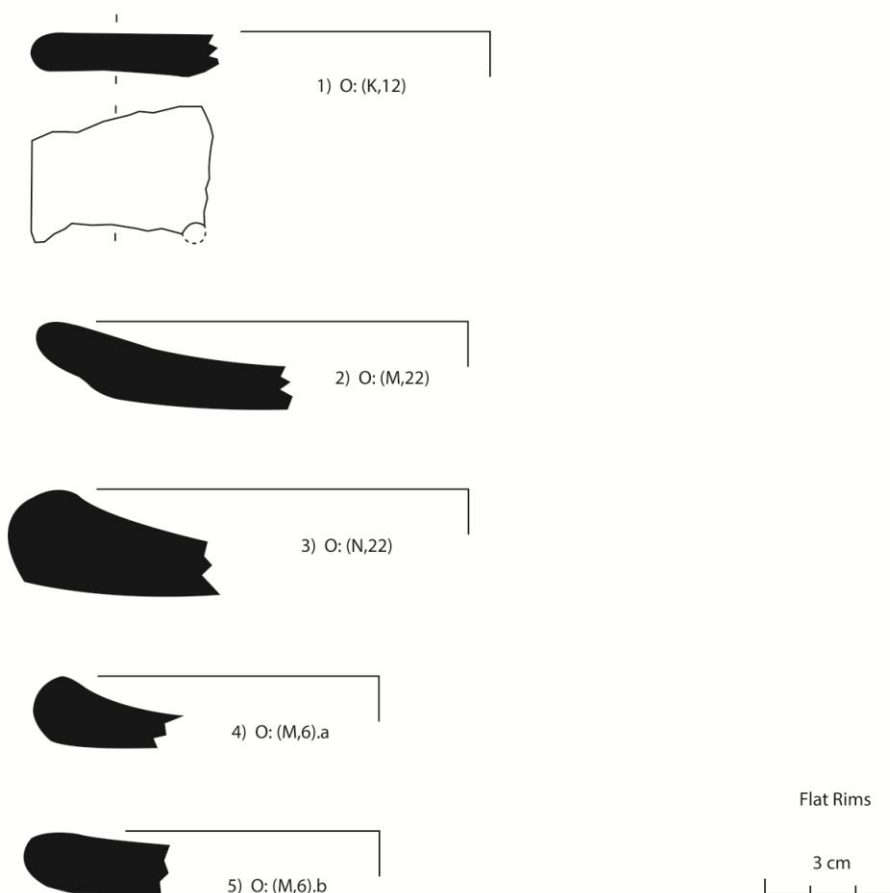


Figure E.13. Flat rims.

### E.5. Vertical and sub-vertical rims

These vessels are all characterized by the vertical, or very near vertical, orientation of their rims. However, there is great diversity in their diameter, morphology, and composition. It seems very likely these rims represent a range of functionally different vessels with widely different body types. The wider ones with the slightly open profile and cut exteriors, for example, may have been bowls or open pots, while the narrower, truly vertical ones were likely the necks of pots. Cups, bowls, or basins are also possible forms and functions.

### E.5. (a) Vertical rims

This type of rim included a number of sherds probably covering a range of different vessel types. All have a generally vertical profile, most with fairly parallel walls. The 22 examples of this type, then, have been subdivided into 5 different possible types based on profile and other attributes such as diameter, though such groupings are very tentative without more complete vessel fragments.

Type 1 sherds (Figure E.14; n=4), are a few degrees more open than 90°, though their profile is very linear. In this way they are not dissimilar from many of the "open, unrounded" rims, though they are all more vertical and consistent in their angle. Each example of Type 1 has a faint trace of an inward curvature below the rim as though they are the rims of basins or platters. The diameters are quite large, about 30, 50 and 60 cm. The two examples from surface collection N, Agay Midir, and the one from collection J, the saddle between Tarla Terrara and Tabot Madera, have fairly uniformly parallel sides, while the example from surface collection B at Tabot Madera is rather bulbous. All are oxidized brown or red and have both *geha* and sand temper, though three of the four have more sand than *geha*. All have at least one temper class at 5% or greater.

Type 2 sherds (Figure E.15; n=7), with their vertical walls and narrow diameter are probably the rim and necks of jars. Diameters vary somewhat, the smallest being 5 cm, while the rest measure between 14 and 23.5 cm. All have sand and *geha* tempers, though all are 5% of any temper and less. Surface treatments vary though all have at least one burnished surface, whether it be outside or inside. One from Unit 6 also has sgraffito on the interior and exterior of the rim. Without more of the body, determining if these are all jars of the same type is impossible. Likewise, the different surface treatments may suggest they also served different functions even if they shared similar forms. However, jars with similar vertical necks and rims and a globular body, sometimes accompanied with a handle, have been used for storing dry goods like spices, incense, and sugar historically.

Type 3 sherds (Figure E.16; n=5) are all similar to Type 1 in that they are a few degrees more open than 90°, though their sides are significantly straighter and have come from a variety of contexts. The smallest rims are 17 and 18 cm in diameter, while the



largest is 45. All have sand and *geha* tempers, with either representing 5% or frequently 10%, of the vessel surface on a fresh break. Like the others in this rim class, all are oxidized brown or red. Of the four in good condition, three are burnished on either the interior or exterior, while one is wet burnished on both sides. At first glance, their profile appears similar to traditional drinking cups (Figure 6.3, top photo). The diameters of the wider ones, however, seem unnecessarily wide for such a function, and may be jar necks like Type 2. Type 4 rims (Figure E.17; n=2) are in all respects similar to Type 3, though they are a little thicker with a slightly beveled lip. The distinction here is perhaps not one that would have been recognized historically.

Type 5 sherds (Figure E.18; n=4) all come from Kiflie Mado surface collection O and Unit 6 and represent the most open of the sherds. Three of the rims' lips are slightly turned outward, while the fourth is slightly turned inward, though none so much as to categorize them elsewhere. Only two rims were large enough to measure their diameters, 12 and 16 cm. All are tempered with sand and *geha*, three with 5% or more of one or the other. All are poorly oxidized brown to dark brown. Like the others in this class, without more of their body, the overall vessel style and function is impossible to determine at this time. It is possible though these rims represent variations on any or all of vessel Types 1-4, particularly the smaller-diameter Type 2 vessels, in this class, the slightly opened lip being merely a feature of the Kiflie Mado potter(s).

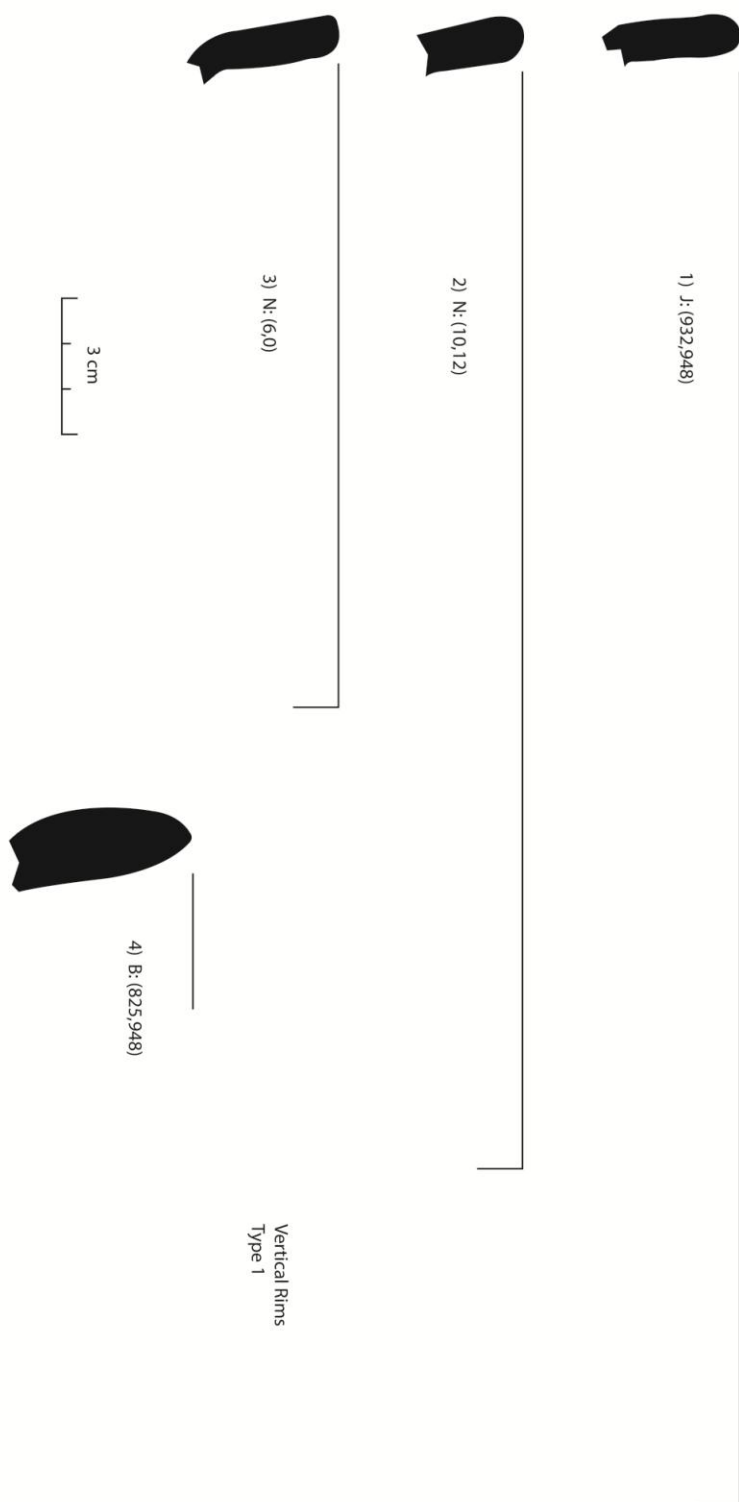


Figure E.14. Type 1 vertical rims.

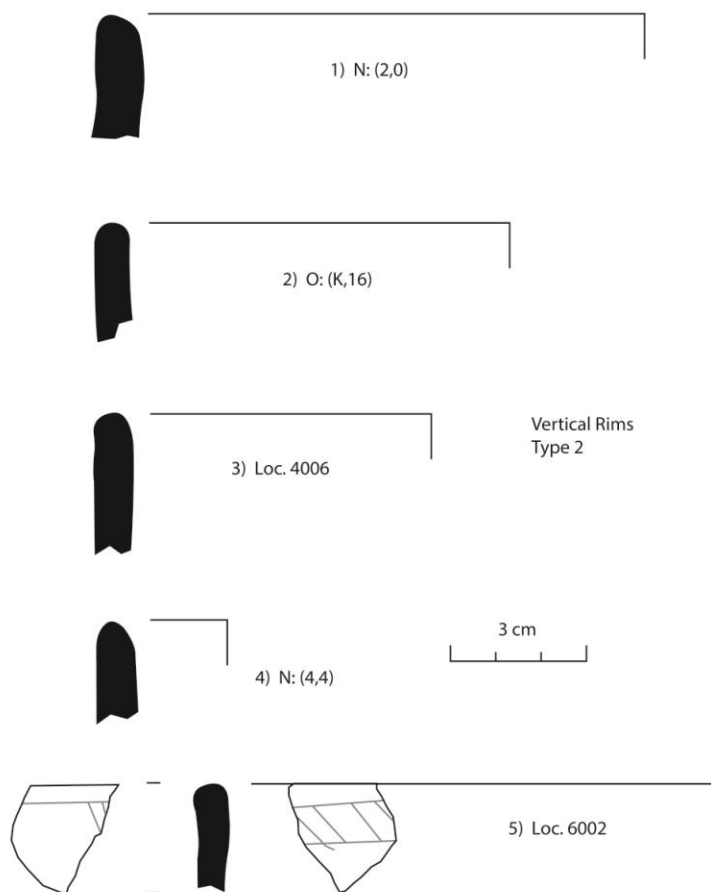


Figure E.15. Type 2 vertical rims.

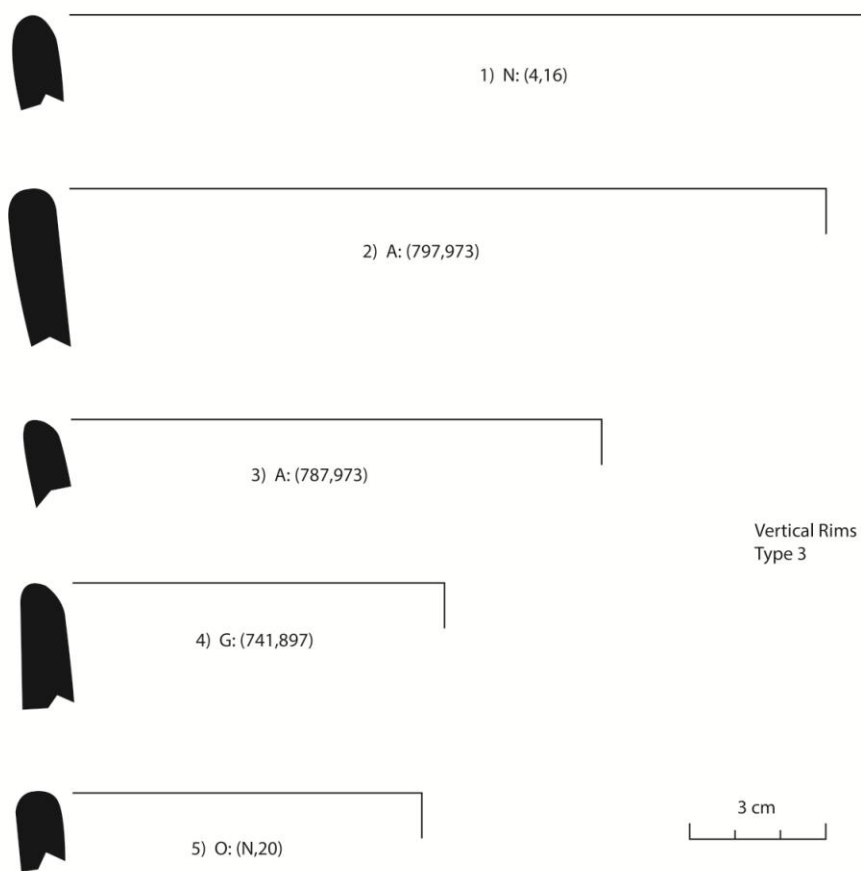


Figure E.16. Type 3 vertical rims.



Figure E.17. Type 4 vertical rims.

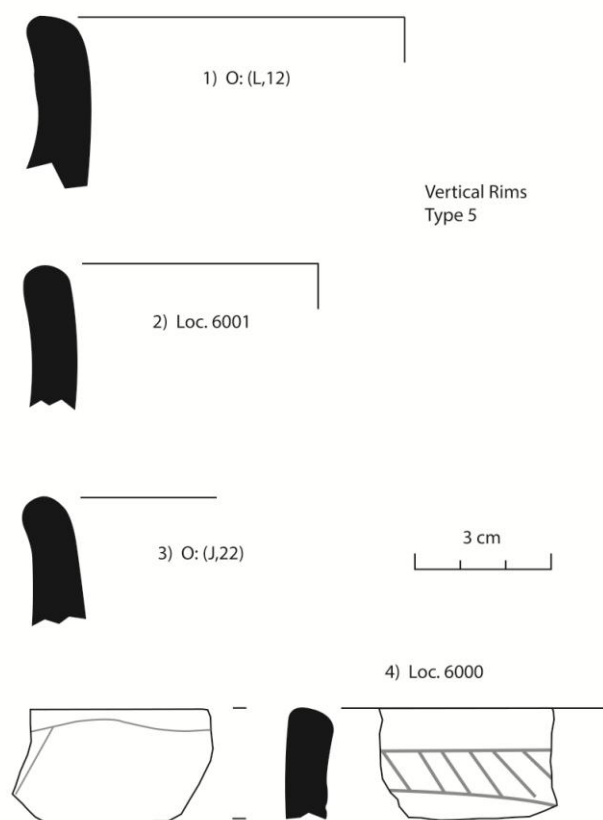


Figure E.18. Type 5 vertical rims.

### E.5. (b) Sub-vertical rims with inverted lips

These five sherds (Figure E.19) from different contexts, including two from Kiflie Mado, are characterized by their rim angle of roughly  $80^\circ$  and, in many cases, a slightly inverted or restricting lip. In the case of the Unit 7 sherd, the lip is distinctly beveled and projects over the vessel interior. As with many of the rim categories, the two from Kiflie Mado share some features not shared among the rest of the assemblage.

The Kiflie Mado sherds are both wet burnished on the exterior, though the sherd from Unit 6 is burnished on the interior as well. The other three sherds, meanwhile, are similarly burnished or slipped and burnished on the interior and exterior, except H:(1244,852), which was cut on the exterior. All are reduced to brown exteriors and have rim diameters between 25 and 35 cm. All have sand and *geha* temper, though

volume varies from 3% or less up to 10% with no pattern visible among this small sample. Both examples from surface collection A and G have sgraffito decoration. Function or complete vessel shape of these sherds is unknown, though perhaps they were some type of rounded, globular pot or bowl, smaller variations with less prominent restricted openings of the type that appear to be represented by the closed rims discussed below.

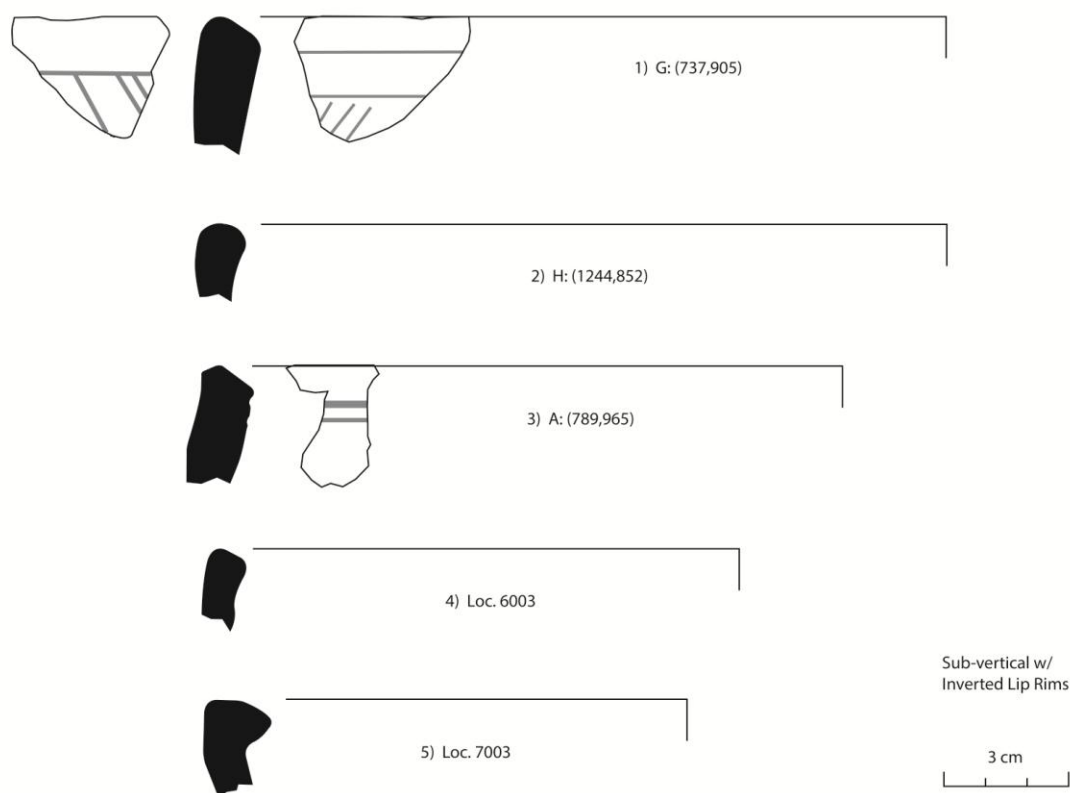


Figure E.19. Sub-vertical rims with inverted lips.

## E.6. Closed rims

These 15 rims (Figure E.20) from a variety of contexts are all characterized by their simple, restricted rims. While most turn inward at an angle between  $50^{\circ}$  to  $70^{\circ}$ , three are a little more severe, closing between  $15^{\circ}$  and  $30^{\circ}$  (example from Unit 5 001 #1, G:(735,897), and N:(2,0)). All but one (Ln:(0,4)) have roughly even, parallel sides. One

is rather thick with a distinctive angular exterior caused by the cutting away of material. The tightly restricted rim from Unit 5 is the narrowest, with a diameter of 11 cm. Another example from Unit 5 has a diameter of 17 cm. This is the largest sherd of this type and gives further evidence for a relatively round, spherical or hemispherical vessel with no discernible neck or other features present. Except for one sherd with a diameter of 20 cm, the rest have large diameters between 30-45 cm with a mean of 37 cm. These size disparities and clustering suggest perhaps two different types or functions of vessels may exist, though all show some relatively similar additional attributes. All but two examples from the first level of Unit 5 have more elaborately finished interiors than exteriors, usually burnished on the interior and plain or wet burnished on the exterior. Ceramic #8 from Unit 5 has sgraffito on the burnished exterior lip. Except for two contemporary wares from surface collection L and H which have an expected high percentage of temper, all have sand and *geha* tempers at 5% or less usually in about equal proportions. No examples from Unit 5 have sand temper in this class, nor in the "open, rounded" class. Besides these features, there is little comparable material against which to compare this material besides the few "sub-vertical" types above. The frequently finished interiors but low temper content could suggest they were used for holding liquids like milk or semi-liquids like butter or fat and perhaps serving them, in the instance of the smaller versions. Tsehaynesh was observed using a vessel similar to these to store her red slip, though it may have been made from a gourd. The rim diameter of the smaller vessels and their simple shape is not dissimilar to some Brown Aksumite ware "hole-mouth" bowls (Wilding and Munro-Hay 1989: 294-299), though their function in the Late Aksumite context is as mysterious there as here. Wilding and Munro-Hay do note, however, that there is no evidence for secondary heating in their examples (as here) and also suggest drinks may have been served from the smaller forms.

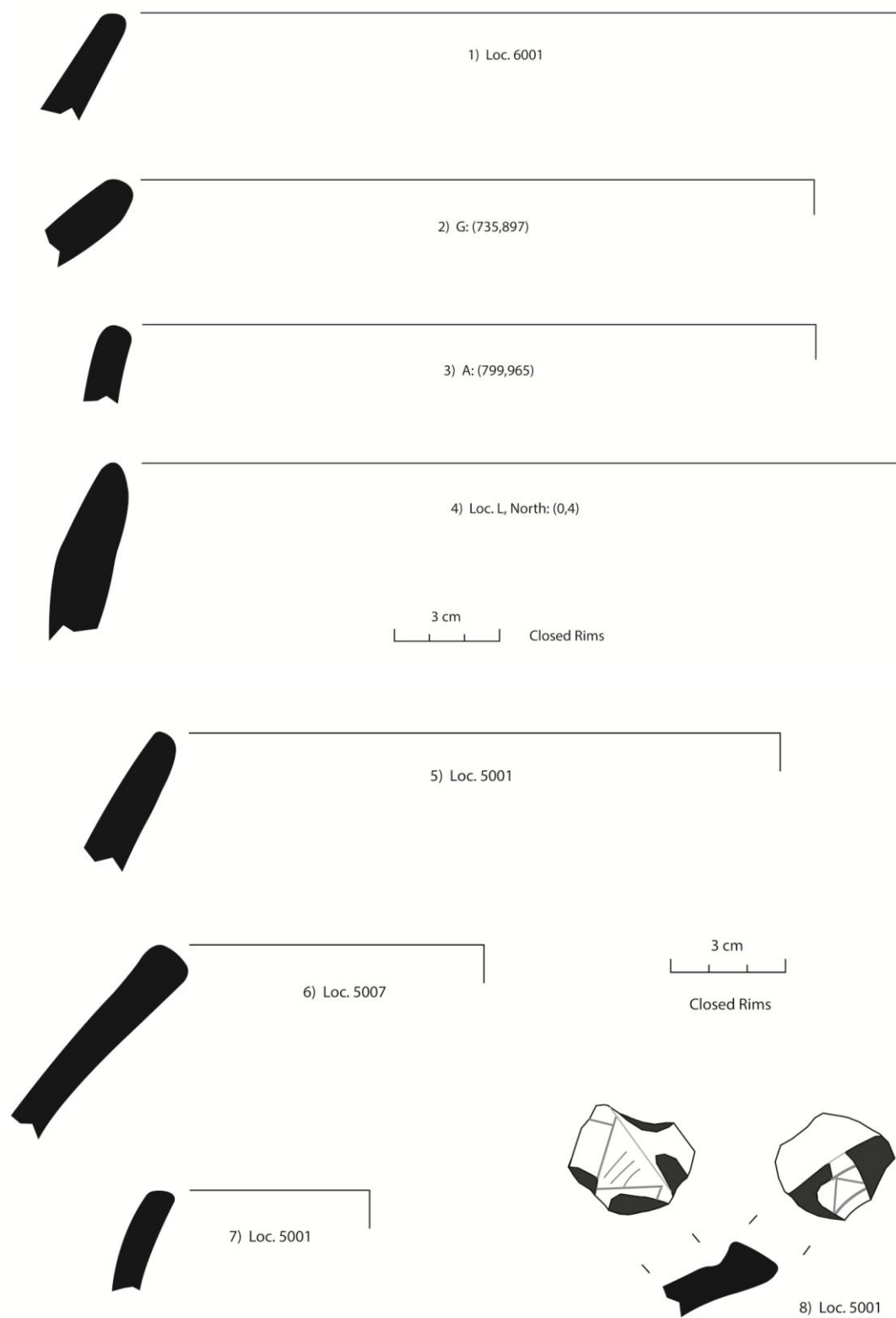


Figure E.20. Closed rims.



## **E.7. Everted and restricted rims**

These diverse rims share the common feature of an everted lip relative to the rim or body. The "open, everted rims" demonstrate this feature in particular, while the "restricted, vertical to everted," comprising only three rims, are perhaps a bit more of a miscellaneous category, two of which share the everted feature. Both the former and latter likely represent a range of vessels, many shared in other categories above. Large pots like those used for water or beer, cut-bottomed bowls, and high-necked, (near) vertical pots are all likely represented.

### **E.7. (a) Open, everted rims and lips**

This diverse class of rims have open profiles and with a curvature leading to an everted rim or lip. With the exception of the Type 4 oddities and sherd A:(785,971), all have fairly similar profile angles and curvatures, though they likely represent a few different types of vessels. All examples from Kiflie Mado except O:(J,16) have very similar morphological traits, which is not unexpected if they indeed were produced by the same former resident potter.

Type 1 rims (Figure E.21) number four examples. Though they all share a number of attributes, there are clear distinctions between the two Kiflie Mado sherds and those from surface collections N and B, and they likely represent two vessel types or styles. All but the example from surface collection B have burnished interiors and plain exteriors, the exception being plain on both sides. One Kiflie Mado example has clearly been cut on the exterior bottom, while the second may have been, but has been roughly smoothed over. All have a high percentage of sand, 5% to 10-20% and low percentage of *geha*. All have rim diameters between 30-45 cm and fairly similar thicknesses.

The Kiflie Mado examples are more complete than the other two examples and have profiles similar to the "Period 3" (17th-18th century) "plates or bowls" recovered from the Meshala Maryam excavations (Chuniaud 2012: 275, Figure 9.14). The other two examples are not complete enough to estimate the vessel form and while they could

be similar "plates or bowls," they may be something different entirely. With finished interiors, a high percentage of sand and fairly large, but consistent diameters, it is possible all four examples were used for cooking, unless the high volume of temper was merely to compete with the stress of natural use in a vessel as large and broad as these. Therefore, they may also have been used possibly for food service or other functions, rather than cooking.

The Type 2 ceramics (Figure E.22; n=8) all come from Kiflie Mado surface collection O and excavation unit 6. Accordingly, many have stylistic similarities such as the angle and curvature of the rim, rim diameter, and slightly overhanging exterior lip, which would not be unexpected if they indeed were all made by the same potter or potters resident to the vicinity. There are some differences among the assemblage, too, however, such as the variation in thickness, and absence of the overhanging lip in some examples.

Of seven sherds with measurable rim diameters, there are two narrow rim diameter categories. Four have rims between 8 and 9 cm in diameter, while three have diameters between 15 and 16 centimeters. Surface treatments among all these are inconsistent. All have at least a wet burnished interior, though some are burnished or slipped and burnished on either the interior or exterior. Most have sand and *geha* temper, usually with one at 5% up to 10%. All have been oxidized brown. One example has parallel sgraffito lines on the interior. While their high percentage of temper might normally suggest they were for cooking, their small rim diameters would seem to preclude this. Another possibility is that the smaller examples, generally with an even lip, were cups or beakers, while the larger, generally with an overhanging lip, were maybe for serving liquids. Alternatively, they may have been the rims and necks for wider-bodied jars, which may explain the desire for so much temper. As with the majority of the Gännäta Maryam assemblage, however, such interpretations are highly conjectural without more complete examples.

Type 3 rims (Figure E.23), numbering 14 examples, are a motley assortment with a variety of attributes, though they lack sufficient features to warrant their classification elsewhere or more extensive subdivisions. Unlike the others, these come from a variety of contexts and have a variety of diameters and thicknesses. A few, however, have notably tapered lips. All are similar in that they are all finished on the inside, wet

burnished usually, though sometimes burnished and, in one contemporary ware example, slipped and burnished. Most have relatively low volumes of temper, 5% or below, though three have up to 10% of sand or *geha*. All are brown except one with superficially oxidized red exteriors. In diameter, they vary widely. The smallest example is 16 centimeters, while the largest is 50, the rest fall in the middle, mostly in the high 20s to mid 30s. This disparity alone indicates the likelihood that the assemblage incorporates a variety of vessel functions and possibly forms, though more complete sherds are needed to clarify these issues.

Type 4 rims (Figure E.24) could be named the "other" category. With only two examples, different from one another, they do not readily fall into any other grouping. H:(1244,852) is a contemporary ware with an accordingly high percentage of *geha*, a distinct ledge rim, and a 50 cm diameter. The rim and interior have been slipped and burnished, though oxidized black, while the exterior was plain. Though the rim is quite elaborate, the vessel's size, finish, and prominent rim make it similar to traditional cooking pots like the pots in Figures 6.1 and the carinated pots discussed in Chapter 6 (especially Figure 6.13). The other sherd from Unit 5 might be a normal everted lip except for the low ridge running just below the rim. With a diameter of 12 cm, a red, burnished interior and low temper content, intuition suggests this may have been a cup, incense burner or similar to vessels used today to hold hot coals, or some other small, cup-like object.

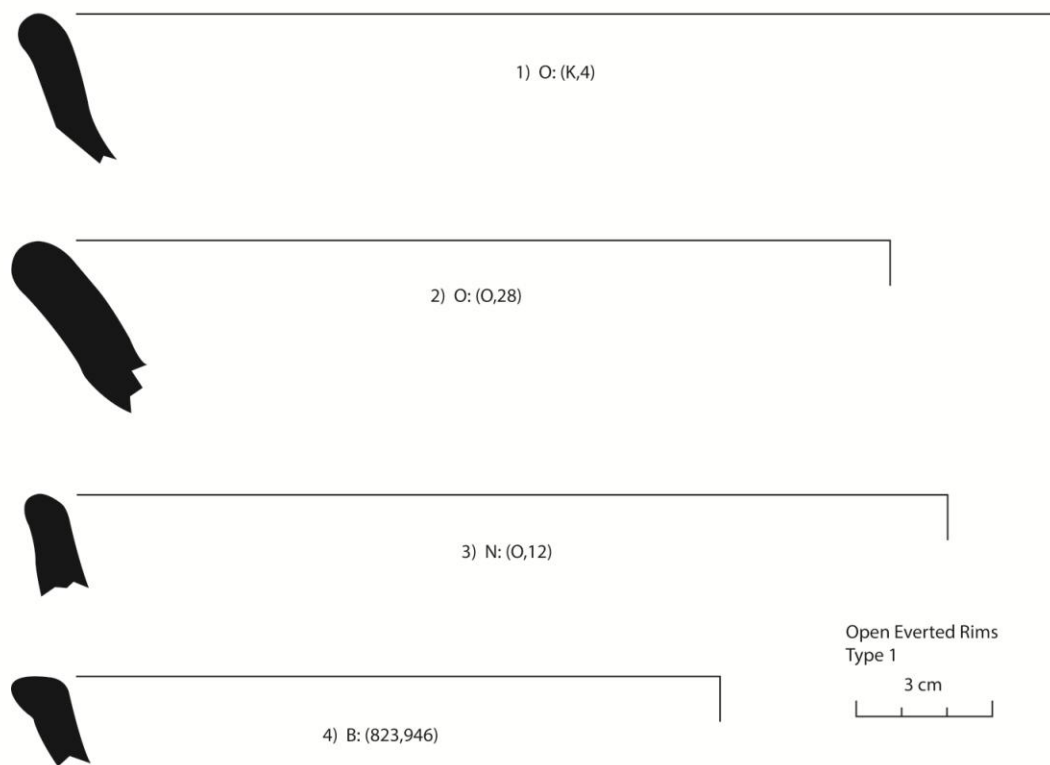


Figure E.21. Type 1 open, everted rims and lips

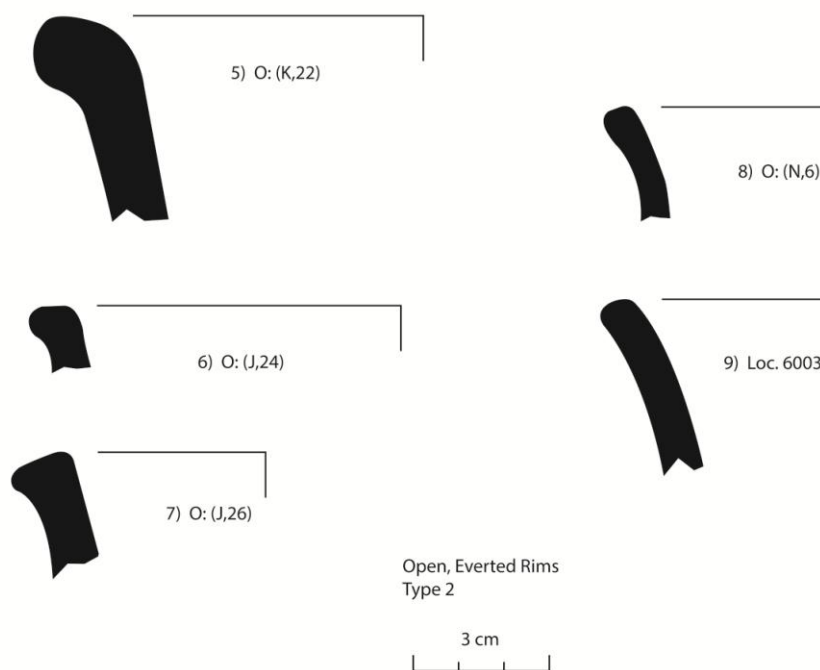


Figure E.22. Type 2 open, everted rims and lips.

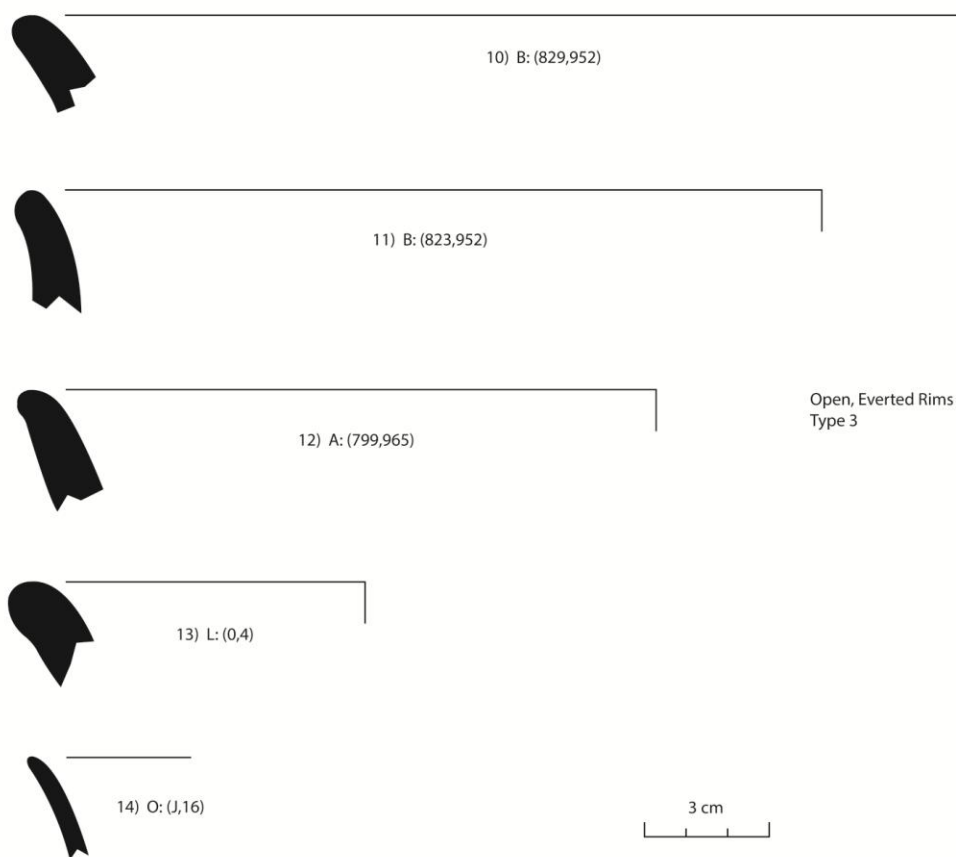


Figure E.23. Type 3 open, everted rims and lips.

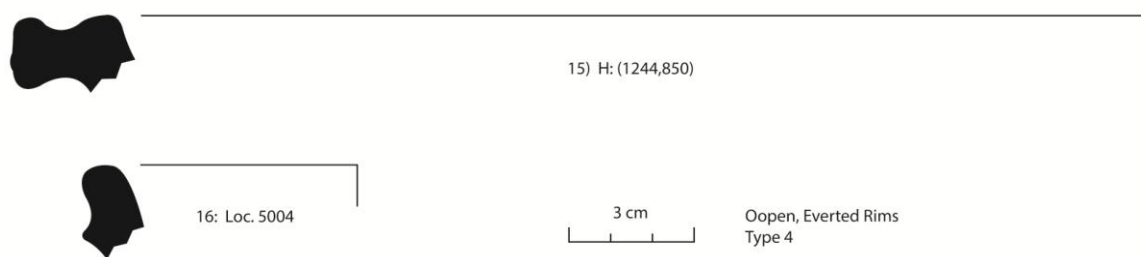


Figure E.24. Type 4 open, everted rims and lips.

### E.7. (b) Restricted, vertical to everted, rims

This class of three sherds (Figure E.25) likely represents a mix of different vessel types, though there is sufficient material leading to the body to get a greater semblance of the vessel form than in the other categories. The vertical-rimmed sherd, N:(8,4), with a

diameter of 8 cm is broken just at the point where the body would appear to open out into a sloped shoulder or globular form. It has very little sand or *geha* temper and a burnished exterior. Its size and composition would suggest it was maybe used for storage of small amounts of dry goods like the small globular pots used today for storing things like sugar or spices. Sherd (A:793,969) has a strong everted curve that may have descended to a carinated cut-bottom-type pot, or represents a slightly restricted neck over a vessel of unknown form. Its diameter is 15 cm, has very little temper and is slipped and burnished on the exterior rather than the interior, suggesting that a jar, bottle neck, or bowl is perhaps more likely than a cooking vessel, though this cannot be proven. The sherd from Unit 5 is thin and straight, but flares outward dramatically from a closed body or shoulder. With a 17 cm diameter lip, the pinched neck would have left a 13-14 cm opening to the vessel interior. The internal and external surfaces were wet burnished but left otherwise undecorated. With little temper, roughly finished surfaces and small apertures, these vessels may also represent variations on the small, globular storage pots referenced in the discussions of "vertical rims" Types 2 and 5.

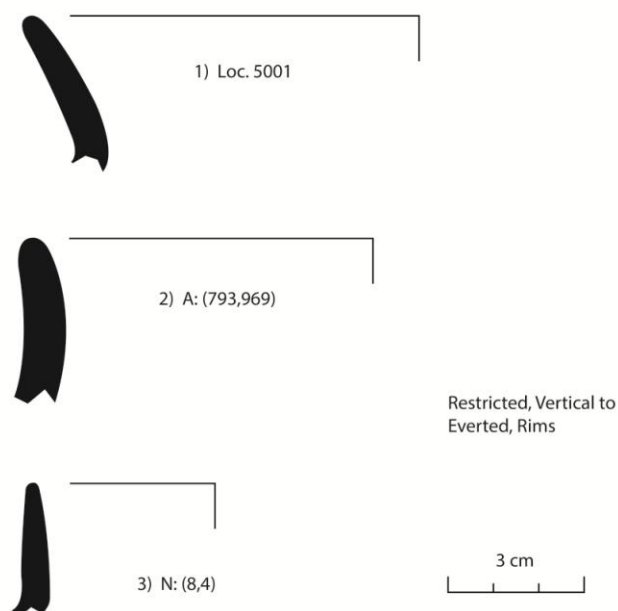


Figure E.25. Restricted, vertical to everted, rims.

## **E.8. Miscellaneous rims and other vessel components**

### **E.8. (a) Closed, recurved rims or carinated vessels**

Examples of this rim type (Figure E.26) are few. Two sherds from Kiflie Mado, O:(K,20) and the one from unit 7, show strong resemblance to modern cut-bottom cooking vessels with a carinated profile as discussed in Chapter 6, though with a slightly more inverted rim. The other three examples are very small and have a similar lip profile and angle, though do not possess enough of the rim to hint at the larger vessel form. The interiors of all these rims are burnished and all but one is burnished on the exterior. All are slightly oxidized to brown or dark brown. One example has a veneer of char on its exterior. Average rim diameter is 21.1 cm with a standard deviation of 7.3 cm. Thickness of the bodies is similarly consistent with an average of 9.4 mm and a standard deviation of 1.16 mm. While the form, burnishing, and presence of char suggest they may be cooking vessels, all have 5% to less than 3% temper inclusions and so they may rather have been used in food service, or possibly both.

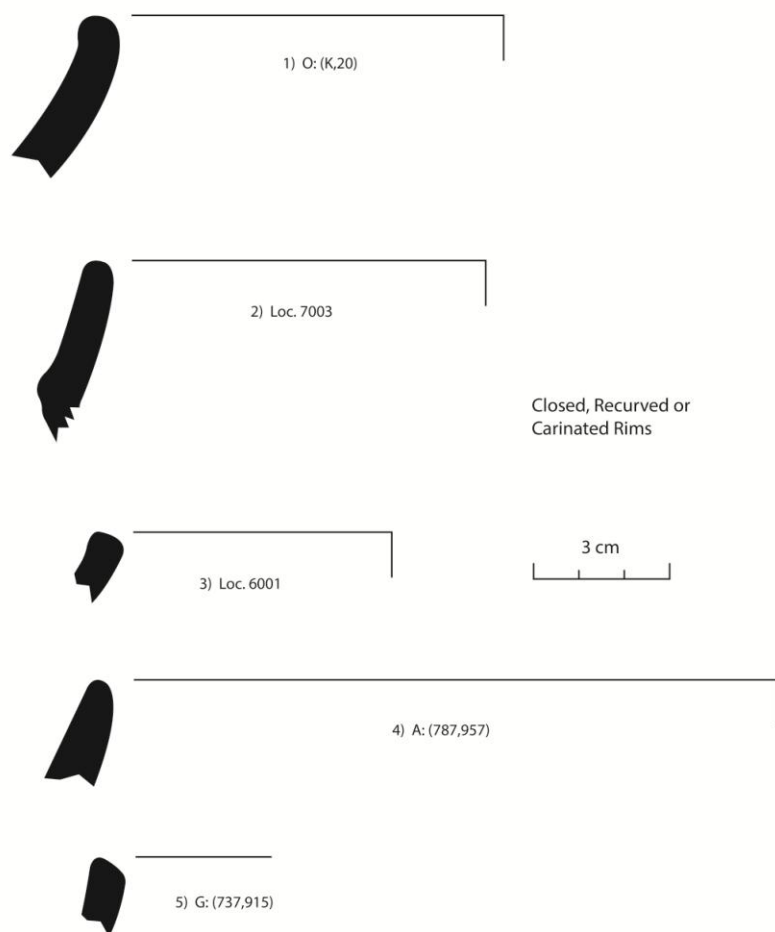


Figure E.26. Closed, recurved rims or carinated vessels

### E.8. (b) Bulbous-lipped rims

This class of rims represents a series of open to closed rimmed vessels, all but one of which come from Kiflie Mado. Again perhaps the stylistic attribute of the bulbous lip is a unique feature of the Kiflie Mado potter(s). The one exception is one example from surface collection H, though there is insufficient rim to determine even basic vessel form such as whether it was opened or closed.

Type 1 vessels (Figure E.27) in this category are two open vessels, though the angles differ slightly. Both are tempered with sand and *geha*; O:(M,12) has a high proportion of very fine-grained sand. The diameters of the two are 21 and 25 cm. Both have brown paste, though one has superficial reduction to black on the interior and



exterior surfaces. Both are burnished on their interiors and wet burnished on the exterior. Final form and function are uncertain, though simple bowls are the most likely possibility.

Type 2 vessels (Figure E.27) have similar rims, but are more vertically oriented than Type 1. The example from Unit 8, Level 4, was reassembled from four pieces making it one of the most complete sherds in the entire Gännäta Maryam assemblage, giving a good impression of the entirety of the vessel form. Furthermore, it was found well-preserved with charring on its exterior and sub-horizontal scars on its burnished interior similar to what one might expect from repeated stirring while cooking. The context of the sherds was the living floor spread centimeters around the cooking fire in Unit 8. Together, this all points very clearly to its function as a cooking pot. Both vessels have similar rim diameters. The former has a diameter of 18.5 centimeters, while its similar cousin is a smaller 13 cm. Both vessels have sand temper, though the Unit 8 vessel has 5%-10% *geha*. By contrast, the second smaller vessel has 5% sand and less *geha*. It is also wet burnished on both sides rather than burnished. All this suggests that while it may resemble the Unit 8 vessel in form, its function may have been different.

Type 3 (Figure E.28) is composed of one miscellaneous bulbous lip with too little body remaining to determine much else about it. The diameter was about 35 cm and it was tempered with sand only. The extant surface is slipped and burnished dark brown.

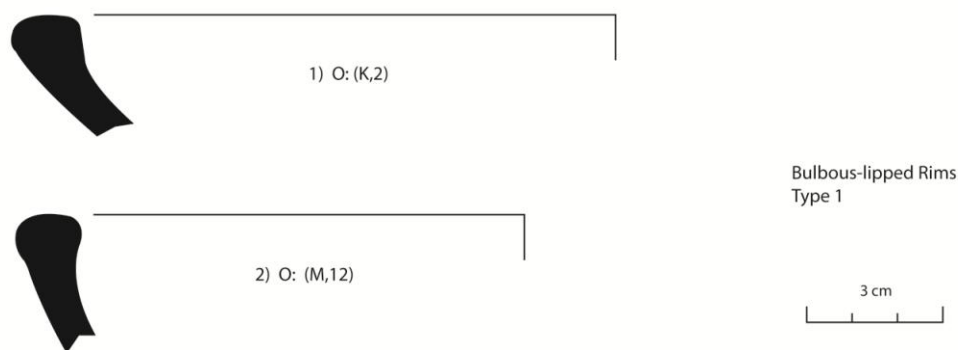


Figure E.27. Type 1 bulbous-lipped rims.

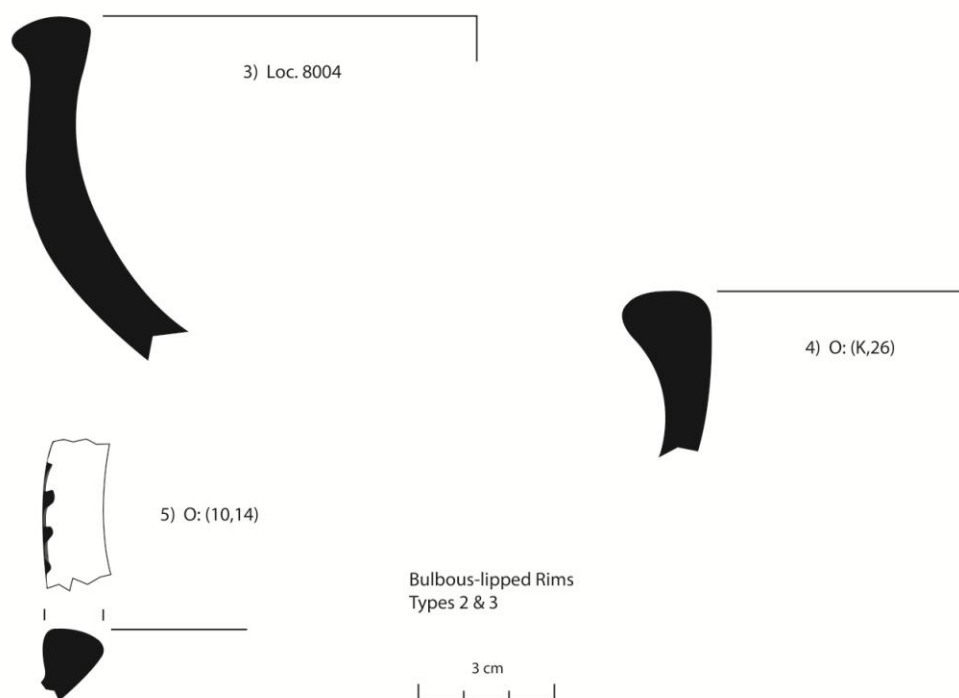


Figure E.28. Types 2 and 3 bulbous-lipped rims.

### E.8. (c) Lids

Two clearly identifiable lids (Figure E.29) were recovered. While I noted that other rims may have been lid fragments, all such attributions were purely speculative based on pieces too eroded or fragmented for certain identity. Both clearly identified lid fragments originated from Kiflie Mado. Both are a brown paste with no surface finish and a light tempering of sand and *geha*. In profile, they are characterized by their small, bowl-like form and projecting top. Similar lids are seen in archaeological contexts (e.g. Munro-Hay 1989: Figure 16.332; Chuniaud 2012: 258 and Figure 9.2) and today (Figures 6.4-5).

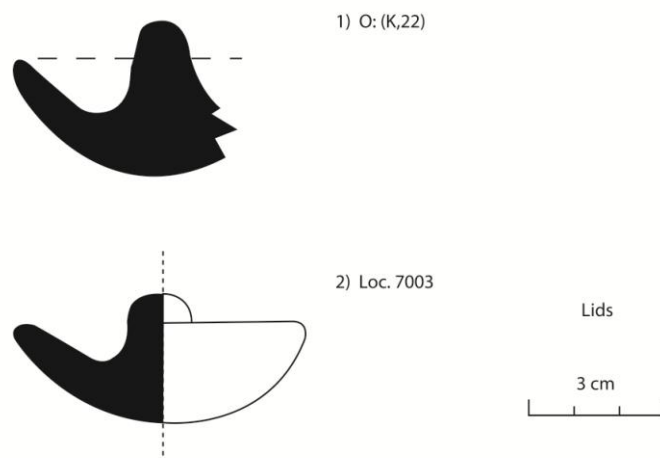


Figure E.29. Lids.

### E.8. (d) Flat bases

Rather than rounded bases or knob feet, a few vessel fragments (Figure E.30) demonstrate the presence of flat bases. Only the two illustrates were sufficiently complete to demonstrate the vessel's diameter. The types of vessels from which these bases originated is unknown, and their compositions are all different, though they represent both historic and contemporary wares.

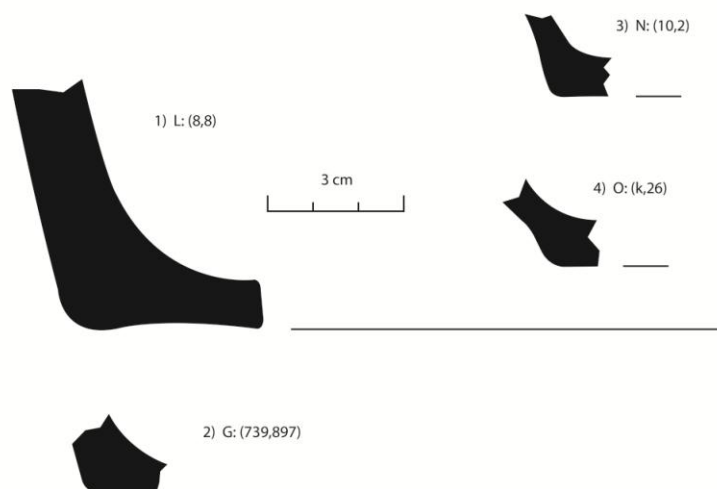


Figure E.30. Examples of flattened bases on otherwise upright vessels. Vessel 1 is a contemporary ware.

## **Appendix F**

### **Ceramic Petrography Report**

The following is a petrographic analysis of ceramics from Gännäta Maryam conducted by Dr. Patrick Quinn of University College London on behalf of Dr. Tania Tribe, organizer of the Solomonik-Zagwe Encounters Project. A few points need to be clarified in order to make sense of this report from the standpoint of this thesis. First, only ceramic samples 1 through 12 and 15 through 18 were recovered by me in the study area of this thesis. The remaining ceramics were recovered by Tribe and other colleagues in other areas around Gännäta Maryam described in the notes. Second, the samples were handed over to Quinn via an intermediary and the report was written prior to my clarification of a few points resulting in some misunderstandings in the report. Quinn believed that the provenience data recorded on the sample bags represented sample numbers and fabric typologies. In fact, while I had conducted the full documentation of the ceramics by this time, I had made no attempt to create a typology of them. Samples were selected to represent a variety of recovery locations, contexts, paste characteristics, and presumed vessel types, information that was not recorded on the bags, but was recorded in my data sheets. Quinn attempted to find correlations between the provenience data, assuming it is typological data, and unsurprisingly found none due to this misunderstanding. Furthermore, due to illegible bags and/or confusion over the meaning of written texts, Dr. Quinn provides a table (Table 1 on report page 13) of the samples with a few errors and omissions. Table F.1-8 here provides a corrected version of Quinn's Table 1 for my 16 samples reorganized into Quinn's petrographic groups supplemented by some of the pertinent macroscopic data I had recorded on those samples.

Table F.1. Quinn's petrographic group 1.

Group	Quinn's Sample #	Collection Location	Rim or Ware	Notes	Temper Type	Temp. Size	Temp. Volume	Surface	Surface Location
Group 1	4	SC G		glassy NPI is flat and long looking	Sand, black	0 - .5 mm	10%	Rough	Ext body
					Geha	0 - 1 mm	10 - 20%	Burnished	Int body
	16	SC N		characteristic thick/heavy orange paste with chunky sand	Sand, black	0 - .5 mm	5 - 10%	Eroded	
					Crystal	0 - 1 mm	3 %		
					Geha	0 - 1 mm	3 %		
	15	SC N			Crystal	0 - 1 mm	3 %	Cut	Ext body
					Sand, black	0 - .5 mm	10%	Burnished	Int body
					Geha	0 - 1 mm	3 %		
	18	SC A		slate grey; very burnished; very light feeling	Geha	0 - .5 mm	5%	Burnished	Both sides

Table F.2. Quinn's petrographic group 3.

Group 3	12	Unit 6, Loc. 5		2 pcs., charred on ext	Geha	0 - .5 mm	5%	Burnished	Ext body
					Crystal	0 - 1 mm	3 %	Smoothed	Int body
					Sand, black	0 - 1 mm	3 %		
	11	Unit 6, Loc. 5		smoothed side reduced	Voids	0 - 1 mm	5%	Smoothed	One side
						0 - 2 mm	3 %	Cut	One side
						0 - .5 mm	10%		

Table F.3. Quinn's petrographic group 4.

Group 4	2	SC O			Geha	0 - .5 mm	10%	Sgraffito	Ext body
								Slip/Burn	Ext body
								Smoothed	Int body
	9	SC H	Rim	red mica	Mica	0 - .5 mm	5%	Burnished	Both sides
					Grey Geha	0 - 2 mm	5 - 10%		
	10	SC B			Voids	0 - 2 mm	5%	Smoothed	One side
					Geha	0 - 1 mm	10%	Rough	One side
					Sand, black	0 - 1 mm	3 %		

Table F.4. Quinn's petrographic group 5.

Group 5	3	SC E			Geha		10%		
					Sand, black				

Table F.5. Quinn's petrographic group 6.

Group 6	5	SC E		pos. slipped, now eroded. Very coarse	Geha			Eroded	Both sides
					Sand, black	0 - 2 mm	3 - 5%		
	6	SC G	Fine Red		Sand, black	0 - .5 mm	5%	Burnished	Int body
					Geha	0 - .5 mm	5%	Slip/Burn	Ext body
					Geha	0 - 1 mm	<3%		

Table F.6. Quinn's petrographic group 7.

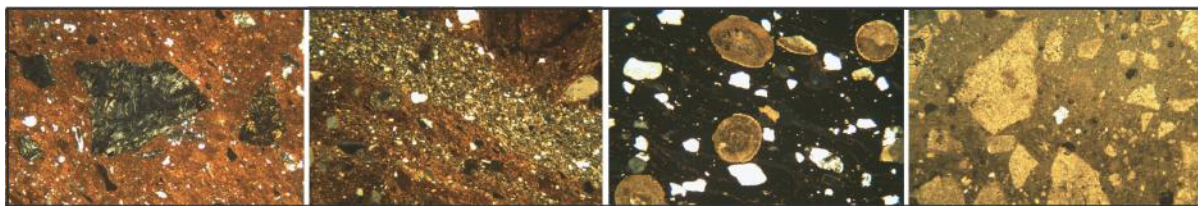
Group 7	7	SC L - NW trans	Rim		Sand, black	0 - 1 mm	10%	Burnished	Int body
					Crystal	0 - 1 mm	<3%	Smoothed	Ext body
					Geha	0 - 1 mm	10%		

Table F.7. Quinn's petrographic group 8.

Group 8	1	SC O		Tuyère fragment, no discernible NPI
---------	---	------	--	-------------------------------------

Table F.8. Quinn's petrographic group 9.

Group 9	8	SC N	Rim		Sand, black	0 - 1 mm	5%	Eroded	
					Geha	0 - 2 mm	5%		
	17	SC A		slate grey; very burnished; very light feeling	Geha	0 - .5 mm	5%	Burnished	Both sides



[www.ceramicpetrology.co.uk](http://www.ceramicpetrology.co.uk)

## **Petrographic Analysis of Medieval Ceramics from Lalibela, Ethiopia**

Dr. Patrick Sean Quinn – 4 October 2013

### **Client**

Tania Tribe, School of Oriental and Asian Studies, University of London, Thornhaugh Street, Russell Square, London WC1H 0XG

### **Background, Sample Materials and Aims of Analysis**

Thin section petrographic analysis has been undertaken on 21 Medieval ceramic samples from recent excavations near the Church of Ganneta Maryam, near Lalibela, Ethiopia. The analysis which compliments ongoing doctoral research at Rice University is part of the Solomonic-Zagwe Encounters Project, which examines the Solomonic expansion in Medieval Ethiopia during the late 13th century. The ceramics include pottery as well as a possible metalworking tuyere (Table 1). Thin section petrography analysis was used to characterise the pottery samples and investigate their possible raw material sources and manufacturing technology. A comparison was made between the macroscopic fabric classification of the samples and their composition in thin section.

### **Methodology**

Small pieces of the 21 ceramic samples were v were impregnated with epoxy resin and prepared as standard 30  $\mu\text{m}$  petrographic thin sections at the Institute of Archaeology, University College London. Those pottery sherd which could be oriented relative to their parent vessel (samples 1, 2, 7, 8, 9, 10, 22) were thin sectioned in a vertical direction. It was not possible to determine the orientation of the other samples. Samples 2 and 23 both feature a vitrified layer. The thin section of these samples cut through this and the non-vitrified body of the sherds. On the request of the client, extra thin sections were made of samples 1, 4, 9 and 22 in order to examine possible intra-sherd petrographic variation. The prepared thin sections were compared to one another under the polarizing light microscope and grouped according to their compositional characteristics and independently of their original macroscopic classification. A comparison of these two means of classification was made. The grouped thin sections were then characterized petrographically and interpreted in terms of their constituent raw materials and manufacturing technology. The possible location of raw material sources used for



the manufacture of the ceramic samples was determined by reference to geological maps (Merla et al., 1979; Tadesse et al. 2003) and reports (Mohr 1983; Toniatti et al 2009) of the study area and the Ethiopian flood basalt province, as well as studies on stone building material from Lalibela (Asrat and Ayallew, 2011; Kiros et al. 2013; Sani et al. 2012). Photomicrographs of the 21 samples are presented in Figures 1-8.

## Results

### Petrographic classification

In thin section, the 21 analysed ceramic sherds could be classified into nine petrographic fabrics based on their composition and texture. Descriptions of these groups are given below. These include interpretations of raw material types and aspects of ceramic manufacturing technology. No names or codes have been given to the fabrics at this point.

#### Samples 4, 15, 16, 18

These four samples are characterised in thin section by the presence of inclusions of volcanic glass and isolated quartz and feldspar in a non-calcareous clay matrix (Figures 1-7). The abundant and conspicuous volcanic glass occurs as variously-shaped shards which have an angular hair-like structure and can be vesicular. They have a colourless to yellow and light brown (sample 15) colour in PPL and are isotropic in XP. They range from fine particles of volcanic ash (e.g. sample 18) to pumice fragments and larger inclusions that might be described as tuff (sample 4). The glassy inclusions are generally fine sand sized or less and have a unimodal, poorly (sample 16) to moderately well-sorted (sample 18) grain size distribution. In addition to the dominant volcanic glass inclusions, the sample also contain less abundant isolated mineral inclusions of quartz, untwinned alkali feldspar, amphibole (samples 15 and 16), biotite (sample 15) and rare plagioclase. In many cases these inclusions have a subhedral shape with some straight sides and rounded corners that is suggestive of phenocrysts that have been isolated from their groundmass, or well-formed crystals within volcanoclastic material. None of the thin sections contain these minerals in association with the volcanic glass fragments, with the exception of a single large tuff inclusion in sample 15 which contains a couple of small feldspar crystals, though this does not rule out the possibility that they come from the same rock or sediment source. The mineral inclusions have a similar size and grain-size distribution as the volcanic material, with sample 18 being finer and better sorted and samples 15 and 16 coarser and less well sorted. Single rounded inclusions of basalt occur in samples 16 and 18. Opaques and iron-rich textural features occur in all samples, which are likely to be related to the weathering of the volcanic material from which the samples were made. All samples have a non-calcareous clay matrix which contains some fine quartz and opaques. Due to the high abundance of the volcanic ash inclusions and its occurrence throughout the thin sections, it is likely to have been naturally occurring in the raw materials used to manufacture the samples rather than having been added as temper. The well-formed mineral inclusions are also interpreted as natural components of the clay. All samples contain only infrequent voids. These are mostly associated with the volcanic inclusions. The long axes of the elongate inclusions in sample 16 are moderately well aligned to the margins of

this sherd, perhaps due to forming. However, it was not possible to determine the orientation of this thin section or the others of the same composition relative to the original parent vessels from which the sherds came. Sample 4 could contain possible relic coils if it were a vertical section. Based on the optical activity of the clay matrix and the colour of the inclusions of amphibole in samples 15 and 16, the sherds were fired  $<750^{\circ}\text{C}$ . Sample 15 was well oxidised, samples 15 and 16 reduced and sample 4 has oxidised margins and a reduced core, perhaps suggesting a short firing duration. Sample 15 stands out from the other three on the basis of the light brown colour of its volcanic material. This maybe due to increased weathering of the parent material or could represent a different composition. It also contains more biotite and amphibole than the other samples. Sample 18 is finer and better sorted.

#### Sample 21

This sample bears some similarities in thin section to samples 4, 15, 16 and 18 on account of the presence of volcanoclastic material and isolated mineral inclusions (Figures 1-7). However, it differs from these in several respects and is therefore likely to have been made from a different raw material source. As with samples 4, 15, 16 and 18, the dominant material in this sample is volcanic glass. However, this occurs mainly as lumps of tuff composed of colourless, isotropic randomly oriented shards set within a very fine brown isotropic partially devitrified glassy matrix. Only isolated fragments of volcanic glass with a vesicular or cellular structure of the type seen in samples 4, 15, 16 and 18 occur. The tuff inclusions vary greatly in shape and size (up to 2.5 mm), giving the fabric poorly-sorted, chaotic appearance. Isolated mineral inclusions of quartz, untwinned alkali feldspar, clinopyroxene, rare clinopyroxene, plagioclase and possible olivine occur. These can be subhedral and appear to have derived from the tuff, given that a few tuff inclusions contain clasts of quartz and/or feldspar. The composition of the mineral inclusions in this sample differs from that of samples 4, 15, 16 and 18 due to the presence of clinopyroxene and the absence of amphibole. The tuff and mineral inclusions appear to have been naturally occurring components of a clay formed on/from volcanoclastic material, rather than having been added as temper. Rare rounded inclusions of weathered basalt might indicate that the clay was transported somewhat and incorporated material from another volcanic source. The sample has a non-calcareous clay matrix that is rich in opaques and reddish pseudomorphs. It contains more voids than samples 4, 15, 16 and 18, which are mainly vugh-shaped. The sample was fired  $<850^{\circ}\text{C}$  in a moderately oxidising atmosphere.

#### Samples 11, 12, 19

These three samples are characterised by the presence of mineral inclusions of quartz and feldspar, plus possible grog in a non-calcareous matrix (Figures 1-7). The distinctive mineral inclusions are composed mainly of quartz, untwinned and simply twinned alkali feldspar, with rare inclusions of plagioclase, amphibole and microcline. The mineral inclusions have a rounded to subhedral shape and are well preserved, suggesting that they came from a volcanic igneous source. Sample 11 contains two rounded fragments of fine-grained, glassy rhyolite with flow structure, which contain phenocrysts of quartz and alkali feldspar. These suggest that the mineral inclusions in the samples could have a similar origin. The isolated mineral inclusions/crystals have a variable, poorly-sorted size distribution and can reach up to

1.25 mm. Samples 11 and 12 contain generally angular argillaceous inclusions of various sizes (up to 2 mm) composed of clay and fine angular quartz and feldspar, as well as iron-rich weathered material. These are compositionally similar to the parent fabric and can be hard to distinguish from it, save from the presence of ring voids. They appear to be grog temper that was produced by the crushing of pottery of a similar composition to the parent fabric, though no large quartz or feldspar inclusions are present in any of the particles. Such features are absent in sample 19. A possible relic vessel surface is present on one possible grog fragment in sample 11. The clay matrix of these three samples is non-calcareous and contains fine angular quartz and feldspar and abundant opaques and iron-rich pseudomorphs. All samples contain significant porosity in the form of elongate voids (especially sample 19) and ring voids surrounding the possible grog (samples 11 and 12). It is not clear whether the igneous material was naturally occurring or added as temper. The three samples have strong (sample 19) to moderate (samples 11, 12) alignment of inclusions and elongate voids sub-parallel to the margins of the sherds/sections. This is likely to be due to forming. However, it was not possible to determine the orientation of the thin sections relative to the original parent vessels from which the sherds came. The samples were fired  $<750^{\circ}\text{C}$  in a weakly oxidising to reducing (sample 12) atmosphere. Sample 11 contains secondary micritic calcite deposited on the surfaces of many voids.

#### Samples 2, 9, 10

These three samples are characterised by rock and mineral inclusions of basic igneous origin (Figures 1-7). The isolated inclusions are mainly clinopyroxene, plus less common orthopyroxene, plagioclase feldspar, biotite and possible olivine. These inclusions have an angular to rounded crystal shape, with some retaining the original crystal shape from the parent rock. This parent rock appears to be basalt, of which several rounded inclusions of varying states of preservation occur in all three samples. The largest of these (8 mm), in sample 2, is composed of well-formed clinopyroxene phenocrysts in a fine, weathered groundmass with abundant lath-shaped plagioclase. In sample 9 there are also coarser, equigranular, aphytic basalt inclusions, rich in opaques. Sample 10 contains a couple of fragments of glassy volcanic rock with well-formed plagioclase phenocrysts, which do not seem to contain ferromagnesian minerals. Samples 1 and 10 also contain other basic or intermediate igneous rock fragments including intergrowths of amphibole, pyroxene and opaques in sample 9 and quartz enclosing pyroxene and opaques in sample 10. The inclusions in the samples are poorly-sorted and of varying shape. They have the appearance of material that is naturally occurring in a clay left from the weathering or erosion of basic igneous rock. Amorphous weathered inclusions and pseudomorphs also occur within the samples. The clay matrix is non-calcareous and rich in opaques and weathered ferromagnesian minerals. Sample 10 does not contain many voids, sample 9 has some conspicuous vughs and sample 2 is bloated in places as a result of its use at high temperatures for some sort of metallic smelting or melting process. The latter sample features a dark, vesicular slag layer, which grades into the vitrified, bloated ceramic beneath it. The thin sections of samples 9 and 10 were taken vertically to the original vessel wall. Neither sample exhibits alignment of inclusions and voids. However, sample 10 may contain possible relic coil structures. Samples 9 and 10 were fired  $<850^{\circ}\text{C}$ . Neither were well oxidised during firing.

### Sample 3

This sample is composed mainly of disaggregated rock fragments of basalt and associated mineral inclusions (Figures 1-7). These fragments, which are medium sand sized or less and have a sub-angular, well-sorted appearance, seem to have come from an equigranular, aphytic basalt composed of plagioclase, clinopyroxene and abundant, small equant opaque iron. This rock seems to be similar to the rare fragments of equigranular basalt in sample 9. Isolated mineral crystals of plagioclase, clinopyroxene and iron occur in the sample and are likely to have derived from the break up of the basalt. Besides the basalt rock material, other inclusions include sub-rounded to sub-angular, subhedral untwinned alkali feldspar, which could represent volcanic phenocrysts. These are reminiscent of the material in other samples. One 2 mm long rounded inclusion of glassy porphyritic acid volcanic rock occurs that is possibly rhyolite and contains several similar feldspar crystals. The sample contains several clay pellets and various types of weathered inclusions, which could have come from the breakdown of the basalt. The inclusions in the sample appear to have naturally occurring rather than added as temper. The raw material could have been a residual clay source, formed on basalt bedrock. However, the presence of rare rhyolite and alkali feldspar suggests the presence of material from another rock type. As such this may indicate that the raw materials were at least partially transported. The sample has a non-calcareous clay matrix. It contains many meso and macro elongate voids as well as meso and macro vughs. The elongate voids are aligned to the margins of this vertical thin section due to forming and the subsequent effect of the alignment of the clay minerals on the drying process. The inclusions have a more random orientation. Firing was <850°C in a moderately oxidising atmosphere.

### Samples 5, 6, 20

These three samples, though not identical, share a similar composition of rounded sand sized basalt rock fragments and mineral inclusions of possible temper in a non-calcareous clay matrix (Figures 1-7). The samples have a slightly (sample 6) to moderately bimodal grain size distribution, which seems to have been caused by the addition of material of coarse sand size or greater. This possible temper fraction contains of fine-grained porphyritic basalt composed of plagioclase feldspar, clinopyroxene, iron and in one large inclusion in sample 5, olivine phenocrysts. Similar basalt inclusions occur in other analysed samples. This type of basalt is less common in sample 6, which also has rounded inclusions of coarse, fresher basalt composed mainly of plagioclase feldspar laths and iron. Sample 5 and possibly sample 6 contain a few inclusions of glassy rhyolite with flow structure and quartz and alkali feldspar phenocrysts. This is the same material that is present in sample 11. Sand sized mineral inclusions that could have been part of the same temper include clinopyroxene, olivine, quartz (sample 5), polycrystalline quartz (sample 20), orthopyroxene (sample 6) and untwinned alkali feldspar. These vary in shape from rounded to angular. Most of the mineral inclusions can be ascribed to one of the rock types present in the samples. The temper may have been an alluvial sand with rounded rock and mineral clasts from a range of igneous rock types. Samples 5 and 20 contain heavily weathered amorphous inclusions, clay pellets (especially sample 5) and significant opaques. Sample 20 contains significant grog temper that is not present in the other two samples. This has a non-calcareous fabric containing disaggregated basalt rock and mineral fragments, opaques and pseudomorphs. It is difficult to distinguish precisely between

the suspected temper and the naturally occurring inclusions. However, finer inclusions in the sample that could have been naturally occurring in the base clay include quartz, feldspar, opaques and red pseudomorphs. The base clay could be a residual or sedimentary clay formed on basic igneous rock. Samples 5 and 20 contain meso and macro elongate voids and vughs that have some preferred alignment parallel to the margins of the samples. Sample 6 contain much less voids in comparison. Samples 5 and 6 have dark clay matrices from firing in a low oxygen atmosphere. Sample 20 on the other hand was relatively well oxidised during firing. The optical activity of its clay matrix suggests firing was  $<850^{\circ}\text{C}$ .

## Samples 7 and 22

These two samples are characterised by a distinctive fabric containing relatively well-sorted mineral inclusions of quartz, alkali feldspar and clinopyroxene, plus fragments of rhyolite and basalt in a non-calcareous clay matrix (Figures 1-7). The conspicuous mineral inclusions are composed of rounded to angular quartz, simply twinned and untwinned alkali feldspar, clinopyroxene, olivine and orthopyroxene that have a fresh appearance and are likely to be of igneous origin. These are medium sand sized or less. The samples contain a large proportion of silica-rich volcanic rock fragments that have a light brown devitrified appearance in PPL and are isotropic in XP. These contain possible flow structure and larger angular crystals of quartz and untwinned alkali feldspar that may be the source of these minerals in the fabric. This volcanic material, which is also present in small amounts in samples 5, 6 and 11 is interpreted as rhyolite, though the angular nature of the larger crystals may be suggestive of a volcanoclastic source. The other main type of inclusion in these two samples is rounded fragments of generally equigranular basalt composed of clinopyroxene, plagioclase and euhedral opaque iron, which has weathered to different degrees. It is not clear whether these are the source of the clinopyroxene inclusions in the fabric, as the latter have a larger grain size. However, some more porphyritic basalt fragments occur in sample 22. Rounded chloritised pseudomorphic inclusions occur in both samples, as do opaques. With the exception of the angular quartz and feldspar, which could have come from the rhyolite, most inclusions in the samples have a rounded shape and comparable size range, suggesting that they have a similar origin. They could have been either clastic components in a sandy non-calcareous sedimentary clay source, or may represent loose polymict alluvial sand that was added as temper. It is difficult to distinguish between these possibilities, though the former seems more likely. Sample 22 contains a couple of large (up to 1.75 mm) inclusions of iron-stained micritic calcite. The samples contain meso and macro elongate voids and vughs, particularly sample 22. Both thin sections were taken in a vertical orientation relative to the parent vessel. In sample 7 the elongate voids and inclusions at the edges are oriented parallel to the surface of the sherd, whereas the inclusions in the center are randomly aligned and may pick out a relic coil. Sample 22 also contains a possible coil. Firing was  $<850^{\circ}\text{C}$  in a weakly oxidising atmosphere.

## Sample 1

This sample is characterised in thin section by a fine fabric containing quartz, alkali feldspar, pumice fragments, pseudomorphs and burnt out plant temper in a non-calcareous clay matrix (Figures 1-7). The addition of plant temper has been determined by the presence of distinctive elongate parallel-sided voids that contain some charred organic material. The other inclu-

sions appear to have been naturally occurring in a sedimentary clay source. These include angular to rounded quartz, untwinned alkali feldspar, orange and brown chlorite pseudomorphs and opaques, rare vesicular pumice fragments that resemble those in samples 4, 15, 16, and 18 and one inclusion of weathered basalt. The mineral and rock inclusions are relatively well sorted and mostly fine sand sized or less. One large (2.5 mm) rounded inclusion of colourless volcanic glass also occurs. The clay matrix of the sample is non-calcareous and contains abundant iron-rich pseudomorphs and opaques. The elongate voids left from the destruction of the plant temper have a strong orientation parallel to the margins of the sherd in this vertical section. This is likely to have been caused by forming. Firing was at or below  $<850^{\circ}\text{C}$  in a weakly oxidising atmosphere. The core of the sherd is not oxidised, perhaps due to a short firing duration.

### Samples 8, 17 and 23

These three samples have a related petrographic composition that is characterised by poorly sorted rock and mineral inclusions of basaltic origin that exhibit varying degrees of weathering, in a non-calcareous clay matrix rich in iron. Mineral inclusions include well-preserved clinopyroxene, orthopyroxene and rare olivine, plagioclase, polycrystalline quartz and amphibole. Rock fragments of several types of basalt occur. These include rounded, sand-sized inclusions of fine grained, porphyritic olivine basalt and more glassy black and in some cases vesicular basalt with phenocrysts and microphenocrysts of plagioclase that show flow structure. The latter inclusions, which are not present in any of the other ceramic samples analysed in this study are interpreted as volcanic scoria. The samples contain the chloritised remains of basaltic rock and minerals as well as iron-rich inclusions of a range of sizes that might also be weathered basalt or could be fragments of glassy basic rock. The samples appear to have been produced from a clay source containing recently weathered residual material and a component of rounded alluvial clasts. Alternatively, the latter could have been added as temper. that contains Sample 17 has a low porosity, whereas sample 8 has elongate branching crack-shaped voids. The orientation of the long axes of inclusions in sample 8 may pick out a relic coil structure. Sample 23 has a vitrified outer layer that is interpreted as slag. This merges into a highly fired, bloated region of the ceramic. Due to the use of sample 8 at high temperatures, it is difficult to precisely determine the nature of its original fabric. Samples 8 and 17 were fired at or below  $<850^{\circ}\text{C}$  in a weakly oxidising atmosphere.

## Discussion

### Relationship between macroscopic and microscopic fabric classification

Few details of the macroscopic fabric classification of the analysed ceramics was available at the time of writing. Fabric codes were not available for all samples (Table 1) and no explanation of the meaning of the codes was available for detailed comparison with the petrographic fabric classification. Based on the codes alone there is no relationship between the two classification schemes. Most samples that were deemed to be petrographically related in thin section had a different macroscopic fabric code, with the exception of samples 11 and 12. Simi-

larly, ceramics which were ascribed the same macroscopic fabric code were found to be petrographically unrelated in thin section (e.g. samples 11 and 12, sample 2, sample 1).

### Interpretation of provenance and raw material sources

All analysed samples are characterised by mineral and rock inclusions of volcanic origin. With the exception of two micritic calcite inclusions in sample 22, no sedimentary or metamorphic material is present in any of the samples. This dominance of igneous material is in keeping with the volcanic geology of Lalibela and the Ethiopian flood basalt province on which it is located. In this respect, the first impression of the ceramics in thin section is of material that is likely to have been locally made. Indeed the range of different volcanic material that is present in the samples, which includes basalt, rhyolite, pumice, volcanic ash and tuff, is in keeping with the complex igneous geology of the immediate region.

Despite the dominance of volcanic material in the 21 analysed ceramic samples, several distinct fabrics can be distinguished in thin section, which represent the use of compositionally different raw materials and/or paste preparation recipes. By comparing these to descriptions of the local and regional geology, it is therefore possible to speculate about the types and locations of possible clay and temper sources used to manufacture the pottery.

Samples 4, 15, 16 and 18 are characterised by the presence of pyroclastic material of volcanic ash and pumice fragments. Volcaniclastic rock occurs in all of the magmatic units that form the local and regional geology. This includes basic tuff or ignimbrite in the Ashangi Basalts and Amba Aibà Basalts and acidic tuffs in the Amba Alaji Rhyolites. Tuffs and scoriaceous lava flows occur in the Termaber Basalts, though the composition of these is not known at the time of writing. Due to the occurrence of isolated mineral inclusions of quartz and alkali feldspar within samples 4, 15, 16 and 18, which are interpreted as having the same origin as the volcanic glass, their raw materials seem to have come from the more acidic volcanic material of the Amba Alaji Rhyolites. According to the geological map (Figures 9-11), outcrops of Amba Alaji Rhyolites are not present in the immediate vicinity of Lalibela village, but can be found within a few kilometers. The clay source used for the manufacture of samples 4, 15, 16 and 18 is interpreted as having been formed on the acidic tuffs of the Amba Alaji Rhyolites. However, the presence of rare rounded basalt inclusions in 16 and 18 suggests that it may have been transported and received input from another rock type. The Amba Alaji Rhyolites also contain some flood basalt units, which could be the source of this material.

Sample 21 is also characterised in thin section by the presence of glassy volcaniclastic material. However, this occurs mainly as lumps of tuff composed of colourless glass shards set within a very fine brown isotropic partially devitrified glassy matrix. Like samples 4, 15, 16 and 18 it also contains isolated mineral inclusions. The composition of the mineral inclusions differs from that of samples 4, 15, 16 and 18 due to the presence of clinopyroxene and the absence of amphibole. The tuff and mineral inclusions appear to have been naturally occurring components of a clay formed on/from volcaniclastic material. Despite the presence of volcaniclastic material in sample 21, it is likely to have been made from a different volcanic clay source. Given the presence of clinopyroxene, plagioclase feldspar and possible olivine, this may be basic tuff or ignimbrite from the Ashangi Basalts or Amba Aibà Basalts. An al-



ternating succession of basalts and ignimbrites of the Amba Aibà Basalts unit crop out in Lalibela village (Figures 9-11). With this in mind, it is possible that the pot from which this sherd came was produced locally from weathered ignimbrite of the type from which the Lalibela Churches were hewn. As in samples 16 and 18 above, the presence of rare rounded basalt inclusions suggests that it may have been transported and received input from another rock type.

Samples 11, 12 and 19 seem to contain mineral inclusions deriving from an acidic volcanic source as well as a few possible fragments of this rock, which seems to be rhyolite or trachyte. This would suggest that the ceramics from which these sherds could have been made from a clay source formed by the weathering and/or erosion of acid volcanic rock from the Amba Alaji Rhyolites. Rock of this magmatic unit can be found within a few kilometers of Lalibela village (Figures 9-11). The presence of grog in samples 11 and 12 might suggest that these two samples were produced by a different potter and perhaps at a different location than sample 19.

Samples 2, 9, 10 are characterised by rock and mineral inclusions of basic igneous origin, as such they could have been locally made. The isolated mineral inclusions as well as several rounded rock fragments suggests that the parent rock was basalt. Both fine-grained porphyritic and coarser, equigranular, aphytic basalt inclusions occur in the samples, though the former are more common. Basalt is a very common lithology in the Lalibela region and is one of the main constituents of the Ashangi Basalts, the Amba Aibà Basalts and the Termaber Basalts. It is also present in the rocks classified within the Amba Alaji Rhyolites. Distinguishing between material derived from the basalt flows of these different magmatic units is likely to be difficult based on the minute fragments within ceramic sherds. There is no evidence of scoria material in samples 2, 9, 10, perhaps ruling out a source formed from the scoriaceous basalt of the Amba Aibà Basalts, the Amba Alaji Rhyolites or the Termaber Basalts and suggesting an association with massive basalt flows. These also occur in all magmatic units. That olivine does not seem to be common in these samples and orthopyroxene is present might rule out the alkaline Ashangi Basalts which underlie the Amba Aibà Basalts. Both porphyritic and aphytic basalts seem to occur in most units. With this in mind it is not possible to determine whether samples 2, 9, 10 were produced from raw materials close to Lalibela village or material from several kilometers away. The presence of basalt of several types and textures in samples 2, 9, 10 suggests an at least partially transported clay source.

Sample 3 mostly contains mineral inclusions deriving from equigranular, aphytic basalt composed of plagioclase, clinopyroxene and abundant opaque iron. As with samples 2, 9, 10 above, determining which of the basalt flows within the various magmatic units it could have derived from is difficult on the information available at the time of writing. Though, it is possible perhaps to rule out the porphyritic alkaline olivine basalt of the Ashangi Basalts unit. The presence of rare fragments of rhyolite and mineral inclusions deriving from a more acidic source might suggest that the clay source formed in or below the Amba Alaji Rhyolites, rather than above this unit in the local succession.

It is suspected that samples 5, 6 and 20 were produced by the addition of alluvial sand temper containing mineral and rock clasts of basaltic and rhyolitic origin. The practice of adding al-



luvial sand is known ethnographically in the region. Several types of basalt seem to have been present in this temper, including a porphyritic olivine containing type, which might be attributed to the Ashangi Basalts or the upper part of the Amba Aibà Basalts. The rhyolite inclusions are likely to have come from the Amba Alaji Rhyolites. No volcanoclastic material is present in the samples. Samples 5, 6 and 20 exhibit petrographic differences to one another suggesting that they were not made with the same clay and/or source of temper, but were constructed with similar raw materials. Sample 20 contains grog which is not present in samples 5 and 6.

Samples 7 and 22 have distinctive combination of mineral and rock inclusions of several types that might have been clastic components in a sandy non-calcareous sedimentary clay source, or may represent loose polymict alluvial sand that was added as temper. It is difficult to distinguish between these possibilities. However, it is clear that the raw materials used for these samples derives from several types of rock and perhaps from more than one of the magmatic units in the region. The acidic volcanic material is likely to have derived from the Amba Alaji Rhyolites which occur within a few kilometers of the site (Figures 9-11) and the basaltic rock and mineral inclusions could come from one or more sources. The presence of porphyritic olivine basalt might be attributed to the Ashangi Basalts or the upper part of the Amba Aibà Basalts.

Sample 1 was manufactured from a fine clay source with few sizable inclusions that was tempered with plant matter. The latter is not indicative of provenance of the source of the raw material. Rare inclusions of quartz, alkali feldspar, pumice and basalt are all characteristic of the region and perhaps attributable to two or more of the magmatic units. These inclusions as well as iron-rich pseudomorphs in this sample appear to have been naturally occurring in a sedimentary clay source. This may have come from the Lalibela region rather than at higher elevations due to presence of material from a range of units.

Samples 8, 17 and 23 contain fragments of basaltic scoria that could have come from the Amba Aibà Basalts. They also contain rounded, weathered porphyritic olivine basalt that may have been transported from the Ashangi Basalts or another magmatic unit. Given the presence of scoria, it is possible that these samples were made from a clay source within Lalibela village.

On the whole the petrographic analysis of the 21 ceramic samples from Lalibela appears to suggest that these samples were locally made. All rock and mineral inclusions present in the samples can be attributed to one or more of the several magmatic units occurring within a few kilometers of the site. However, the occurrence of several distinct petrographic fabrics made of compositionally different raw materials and with different paste preparation recipes, suggests the presence in this assemblage of ceramics made from different sources of clay and/or temper, perhaps by different potters and workshops in several specific areas. Because of the occurrence of similar lithologies within the different magmatic units, it is in most cases difficult to be specific about the actual sources of raw materials used in the Lalibela region. The presence in the region of regolith composed of weathered bedrock and material transported from elsewhere also hinders detailed interpretation of raw material sources. However, field

sampling and analysis might improve this situation and permit microprovenance interpretations to be made.

Based on the available information about the geology of the Lalibela area, no compositional characteristics are present in the analysed ceramics that might be suggestive on the occurrence of non-local ceramics at the site. However, due to the occurrence of similar rock types over large areas of northern Ethiopia, it is not possible to rule out a non-local provenance for any of the ceramics based on petrography alone.

#### Intra-sherd petrographic variability

On the request of the client, extra thin sections were made of samples 1, 4, 9 and 22 in order to examine possible intra-sherd petrographic variation. Analysis of these under the microscope and comparison with the other thin sections made of these samples revealed no significant compositional variability. Each pair of thin sections had the same types of inclusions and voids in similar sizes and proportions and the clay matrix was comparable. This extended to the presence of rare inclusions such as rounded weathered basalt that was present in both thin sections of sample 1 and iron-rich micritic calcite, which was found in the two sections manufactured from sample 22. The two thin sections were made in a different but adjacent plane of the sherd separated by a few millimeters at the most. It is feasible that a thin section made from opposite ends of a pottery vessel or other ceramic might exhibit greater petrographic variation than is displayed in the duplicate samples analysed here. However, ethnographic studies suggest that potters typically homogenize their clay pastes significant variation is in most cases not expected.

#### Nature of vitrified layer on samples 2 and 23

Samples 2 and 23 both contain black vitrified, iron-rich slag on their outer surfaces. These layers contain rounded vesicles, as well as mineral inclusions that were probably once part of the ceramic fabric. In both samples, this slag layer merges into bloated, over-fired ceramic, which in turn merges into moderately fired ceramic that retains its original fabric character. This gradation is typical of ceramics used at high temperatures for the smelting or melting of metals. Sample 1 was identified as a possible tuyere fragment. However, no slag was detected on this sample. It is beyond the scope of this project to determine the type of metallurgy that ceramic samples 2 and 23 were associated with. This would require scanning electron microscopy, SEM-EDS and/or reflected light microscopy.

#### **References Cited**

- Asrat, A. and Ayalew, Y. 2011. Geological and geotechnical properties of the medieval rock hewn churches of Lalibela, Northern Ethiopia. *Journal of African Earth Sciences* 59: 61–73.
- Kiros, A., Gholap, A. V. And Gigante, G. 2013. Fourier transform infrared spectroscopic characterization of clay minerals from rocks of Lalibela churches, Ethiopia. *International Journal of Physical Sciences* 8: 109-119.

Mohr, P. 1983. Ethiopian Flood Basalt Province. *Nature*, 303: 577-584.

Sani, F., Moratti, G., Coli, M., Laureno, P., Rovero, L., Tonnetti, U and Coli, N. 2012. Integrated geological-architectural pilot study of the Biet Gabriel-Rufael rock hewn church in Lalibela, northern Ethiopia. *Italian Journal of Geosciences* 131: 171-186

Tonietti, U. 2009. *Pilot conservation project on the Rock Hewn Church of Gabriel Rufael in Lalibela*. UNESCO Conservation Action Plan Structural Study. Unpublished report. University of Florence Scientific Mission Lalibela, Ethiopia.

## Tables and Figures

Analytical No.	Sample No.	?	?	Macroscopic Fabric	Other information	Preparation
1			S.C.O	GMKM	Tuyere?	Sectioned twice
2	J28		S.C.O	GMKM		Sectioned through
3	1161, 549		S.C.E	GMTM		
4	7011, 905		S.C.G	GMTT		Sectioned twice
5	1147, 945		S.C.E	GMTM		
6	743, 911		S.C.G	GMTT		
7	2, 2	A.D	S.C.L - NW Trans			
8	4, 16		S.C.N	GMAN		
9	1238, 850		S.C.H	GMAD		Sectioned twice
10	8375, 946		S.C.B	GMTM		
11	6005	A, UID: 232		GMKM		Sectioned twice
12	6005	B, UID: 232		GMKM		
13						
14						
15	4, 6	A	S.C.N	GMAM		
16	4, 6	B	S.C.N	SMAM		
17	7855, 973	A	S.C.A	GMTM		
18	7855, 973B		S.C.A	SMTM		
19	-	A	-	-	See note 1 below	
20	-	B	-	-	See note 1 below	
21	-	C	-	-	See note 1 below	
22	-	D	-	-	See note 2 below	Sectioned twice
23					See Note 3 below	Sectioned through

Table 1. Medieval ceramic samples analysed from Lalibela in this report. Note 1 - From ploughed field on approach to Gannata Maryam Church 1/4/2013; Note 2 - Collected from ploughed field on approach to Gannata Maryam Church 1/4/2013; Note 3 - W. of Ganneta Maryam GPS059 2nd Field (Uphill of 1st Field) Vitrified Pottery 13/11/09.



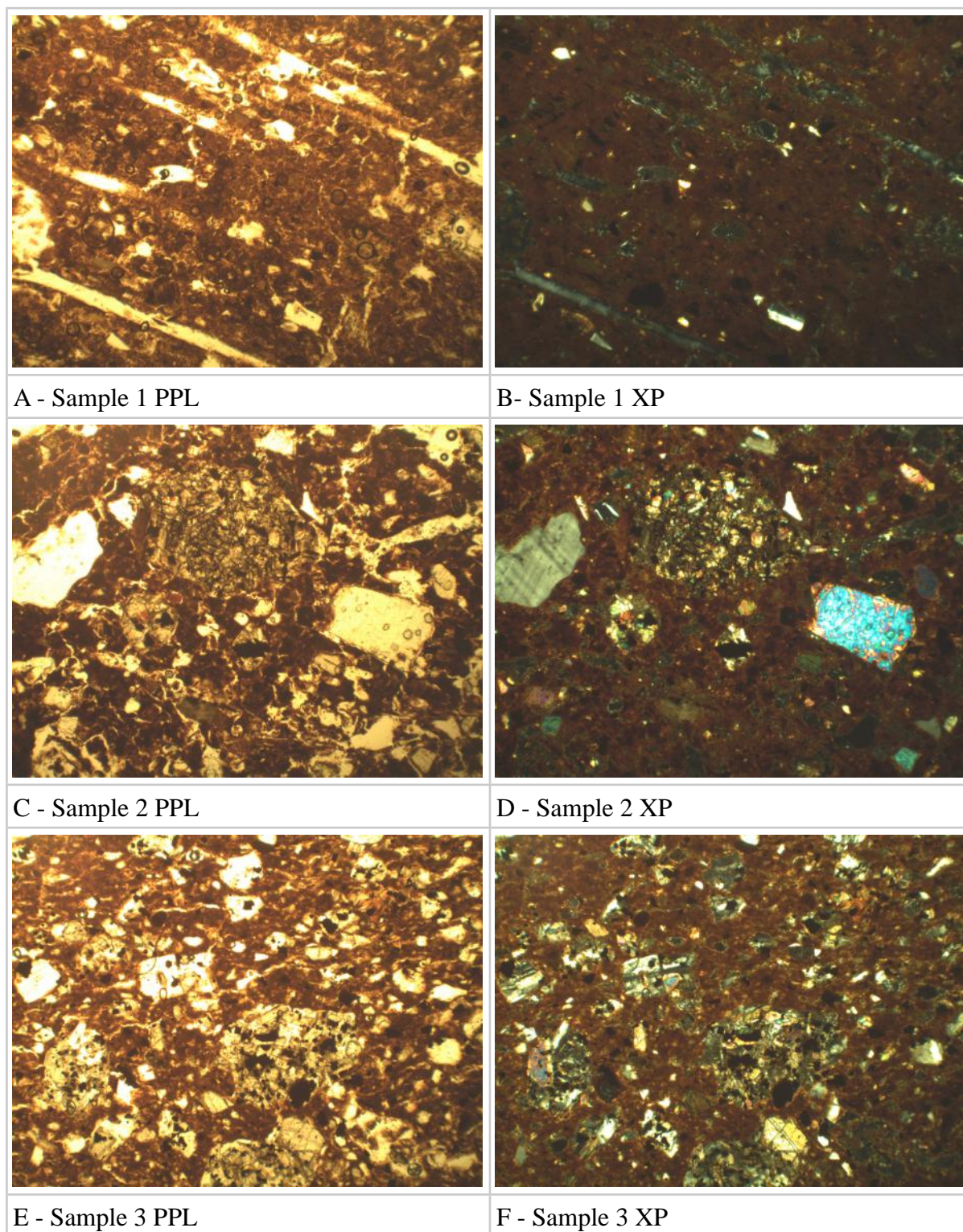


Figure 1. Thin section photomicrographs of Medieval ceramics from Lalibela analyzed in this report. Image width = 2.9 mm. XP = Crossed polars, PPL = Plane polarized light.



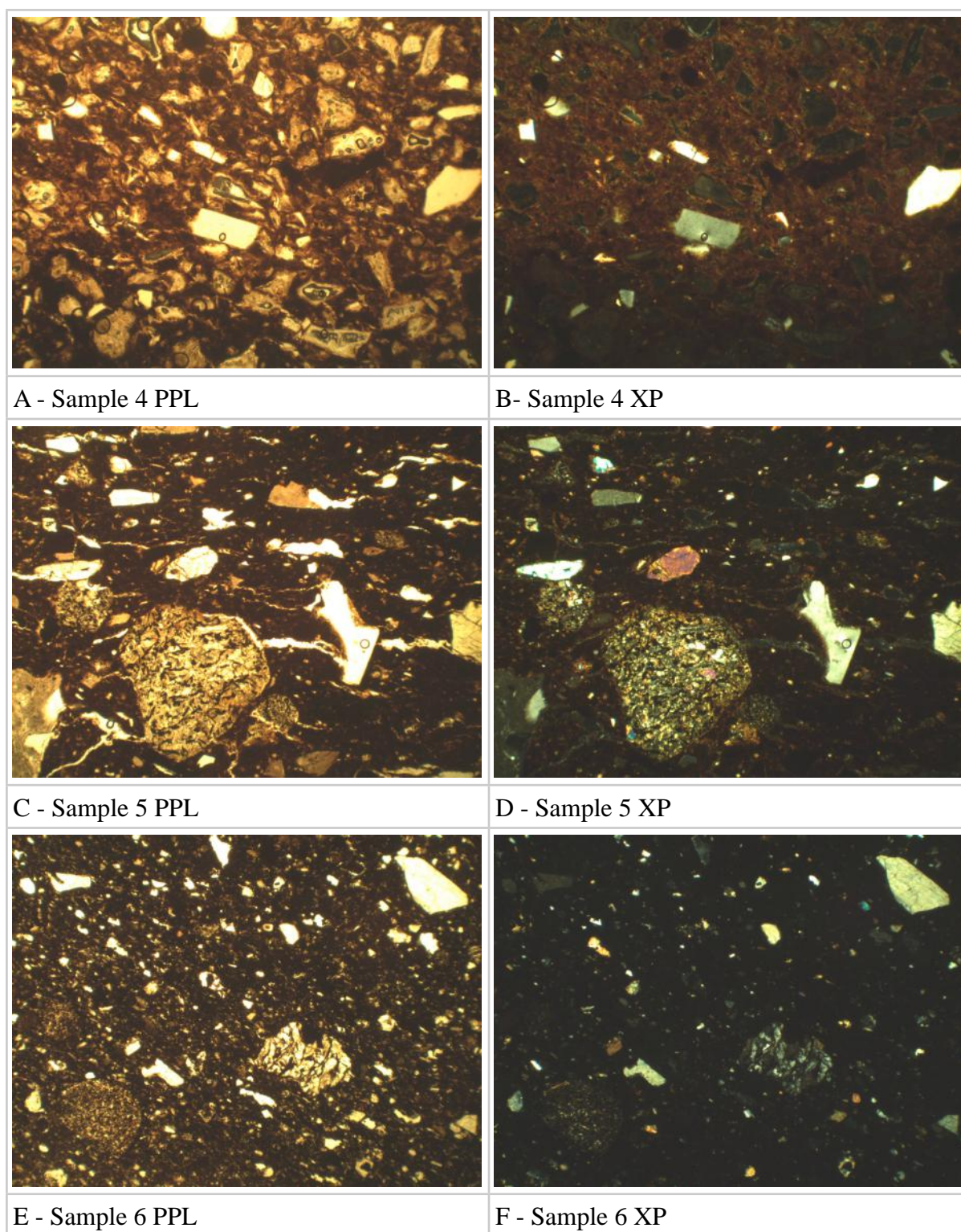


Figure 2. Thin section photomicrographs of Medieval ceramics from Lalibela analyzed in this report. Image width = 2.9 mm. XP = Crossed polars, PPL = Plane polarized light.



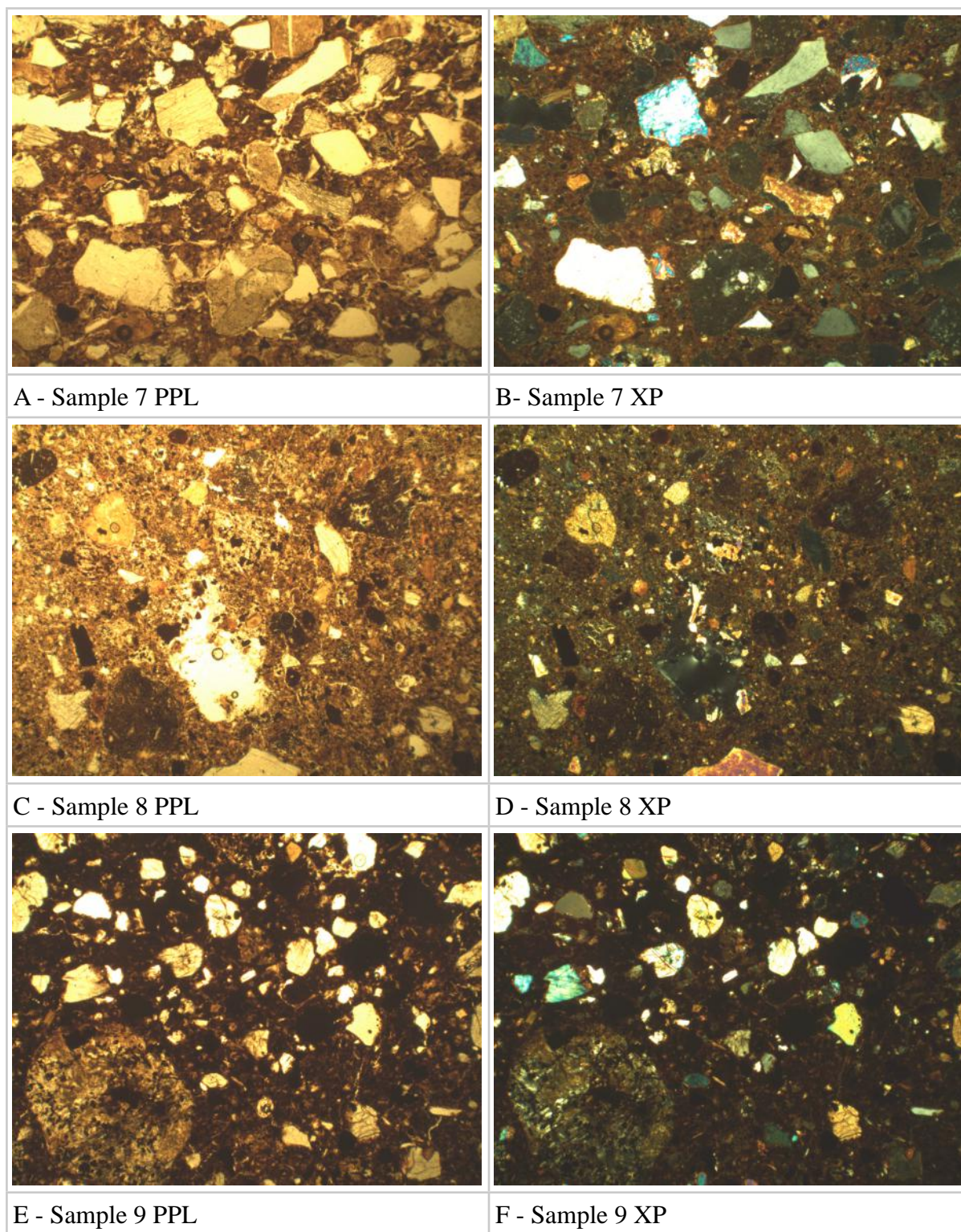


Figure 3. Thin section photomicrographs of Medieval ceramics from Lalibela analyzed in this report. Image width = 2.9 mm. XP = Crossed polars, PPL = Plane polarized light.



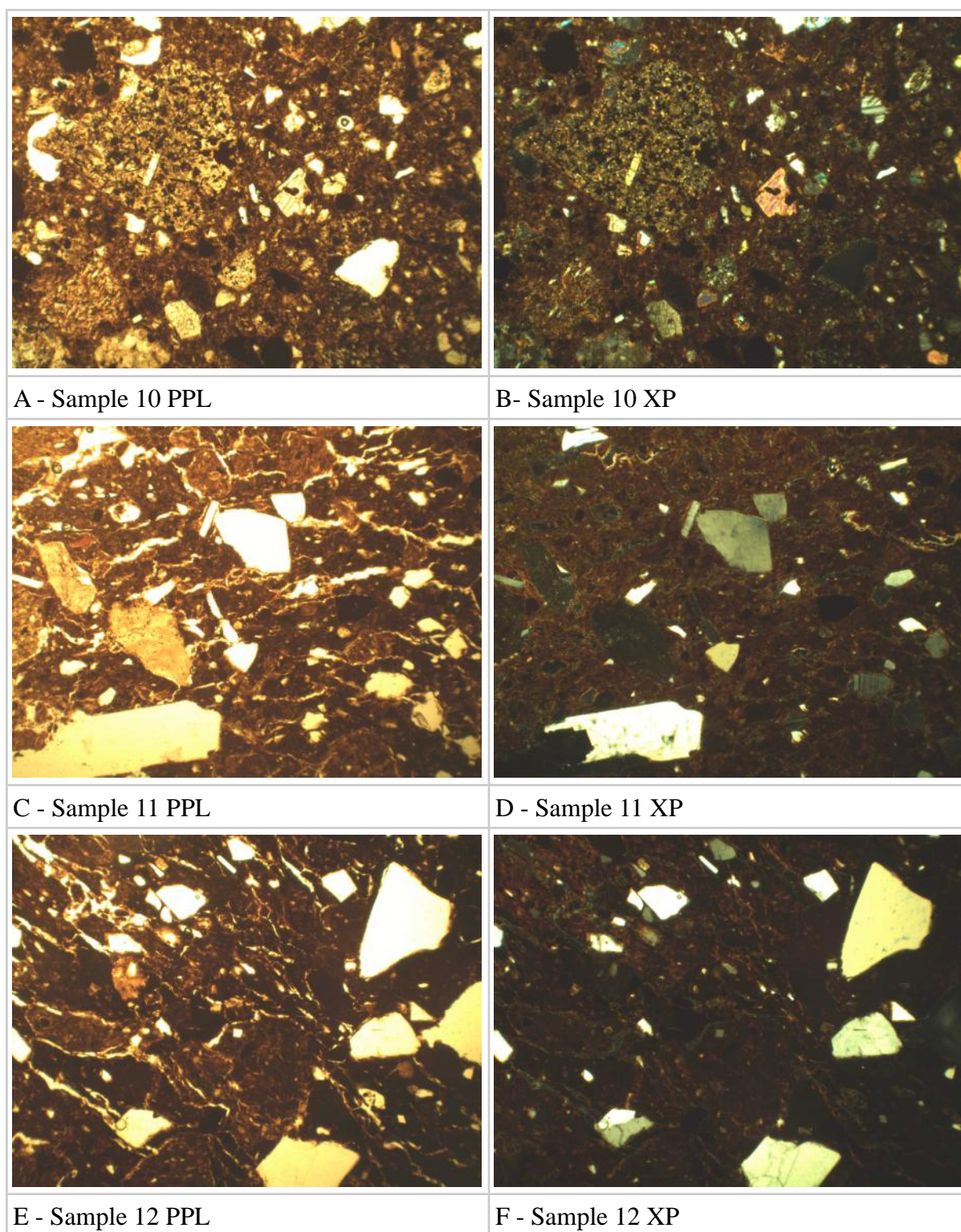


Figure 4. Thin section photomicrographs of Medieval ceramics from Lalibela analyzed in this report. Image width = 2.9 mm. XP = Crossed polars, PPL = Plane polarized light.



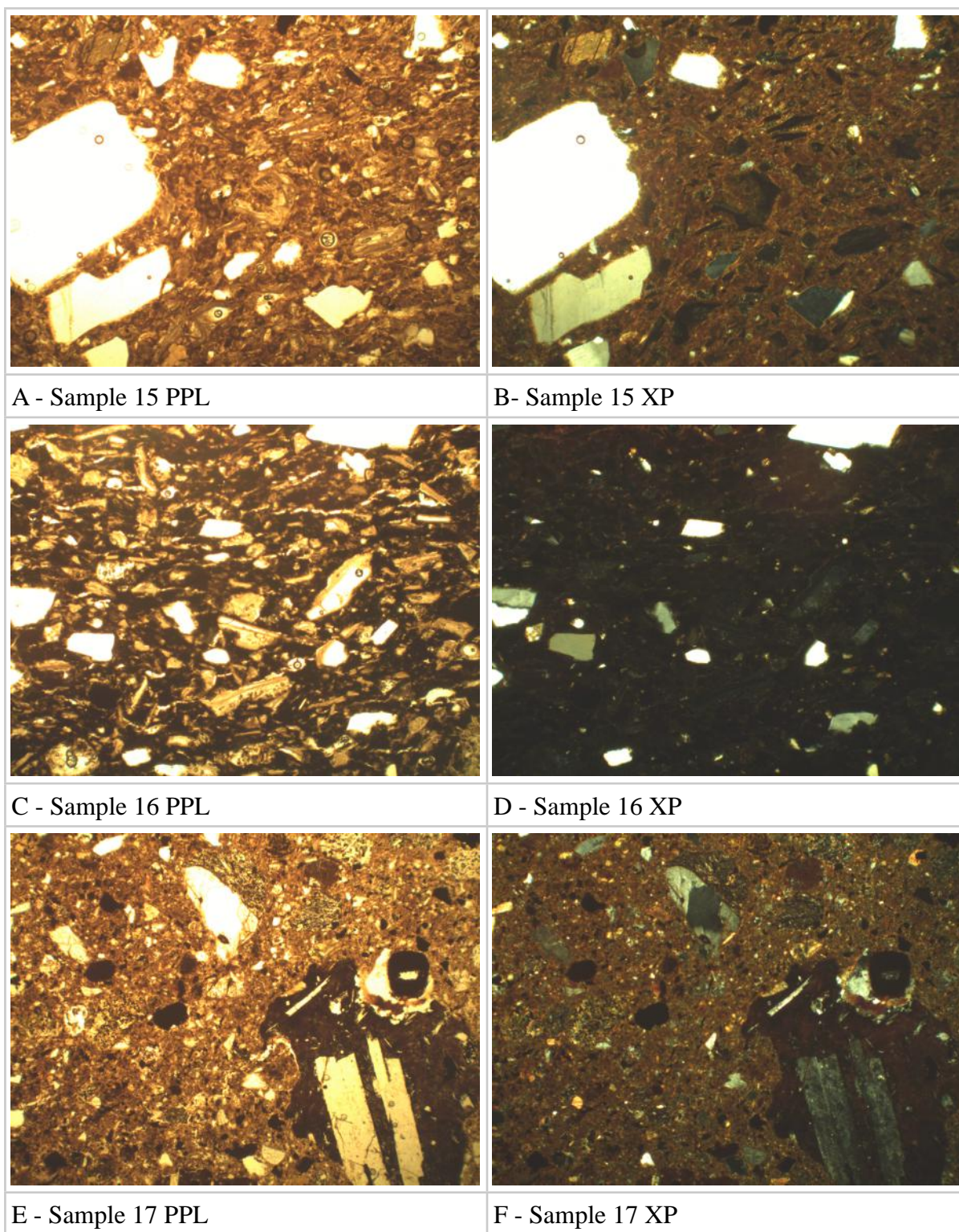


Figure 5. Thin section photomicrographs of Medieval ceramics from Lalibela analyzed in this report. Image width = 2.9 mm. XP = Crossed polars, PPL = Plane polarized light.



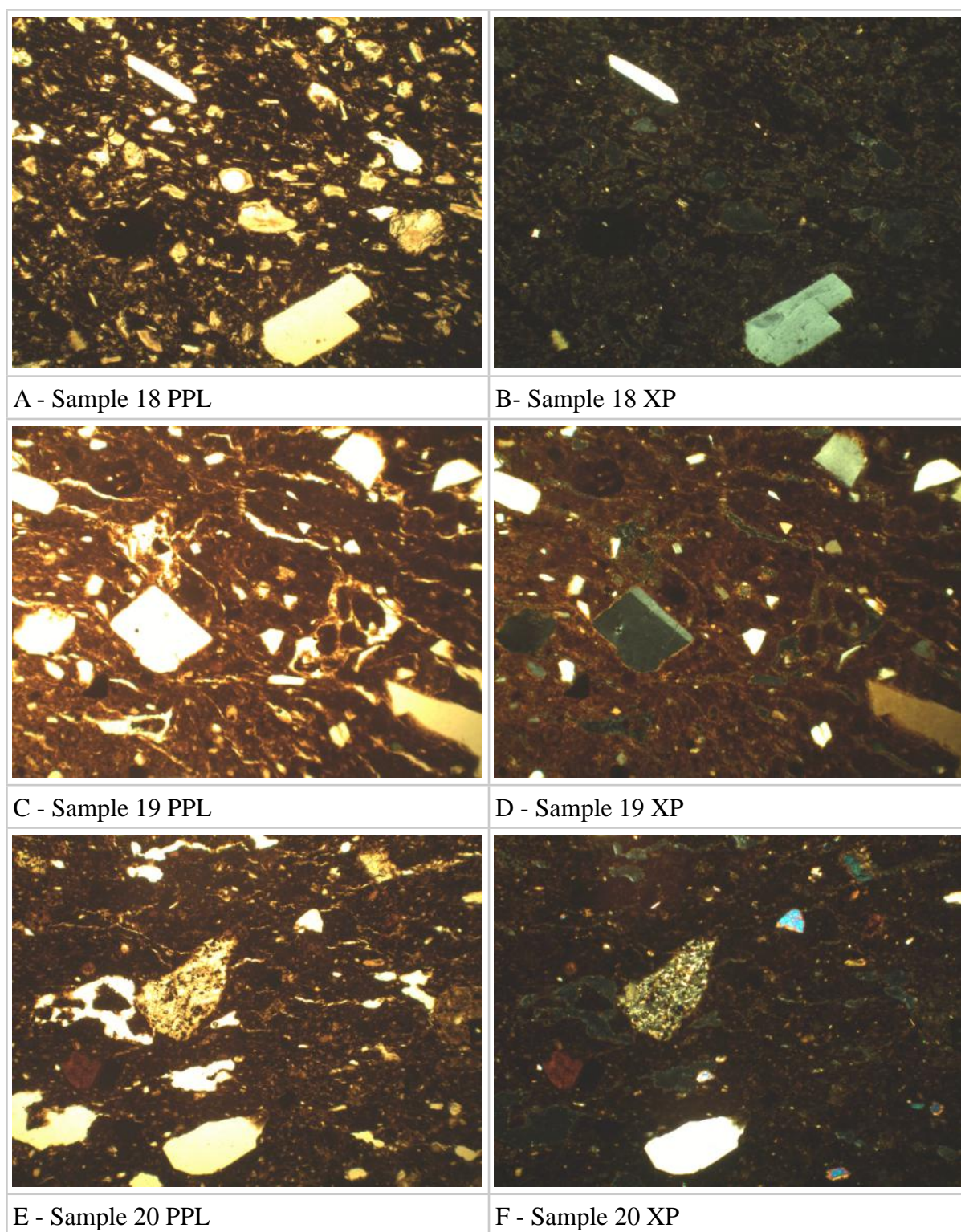


Figure 6. Thin section photomicrographs of Medieval ceramics from Lalibela analyzed in this report. Image width = 2.9 mm. XP = Crossed polars, PPL = Plane polarized light.



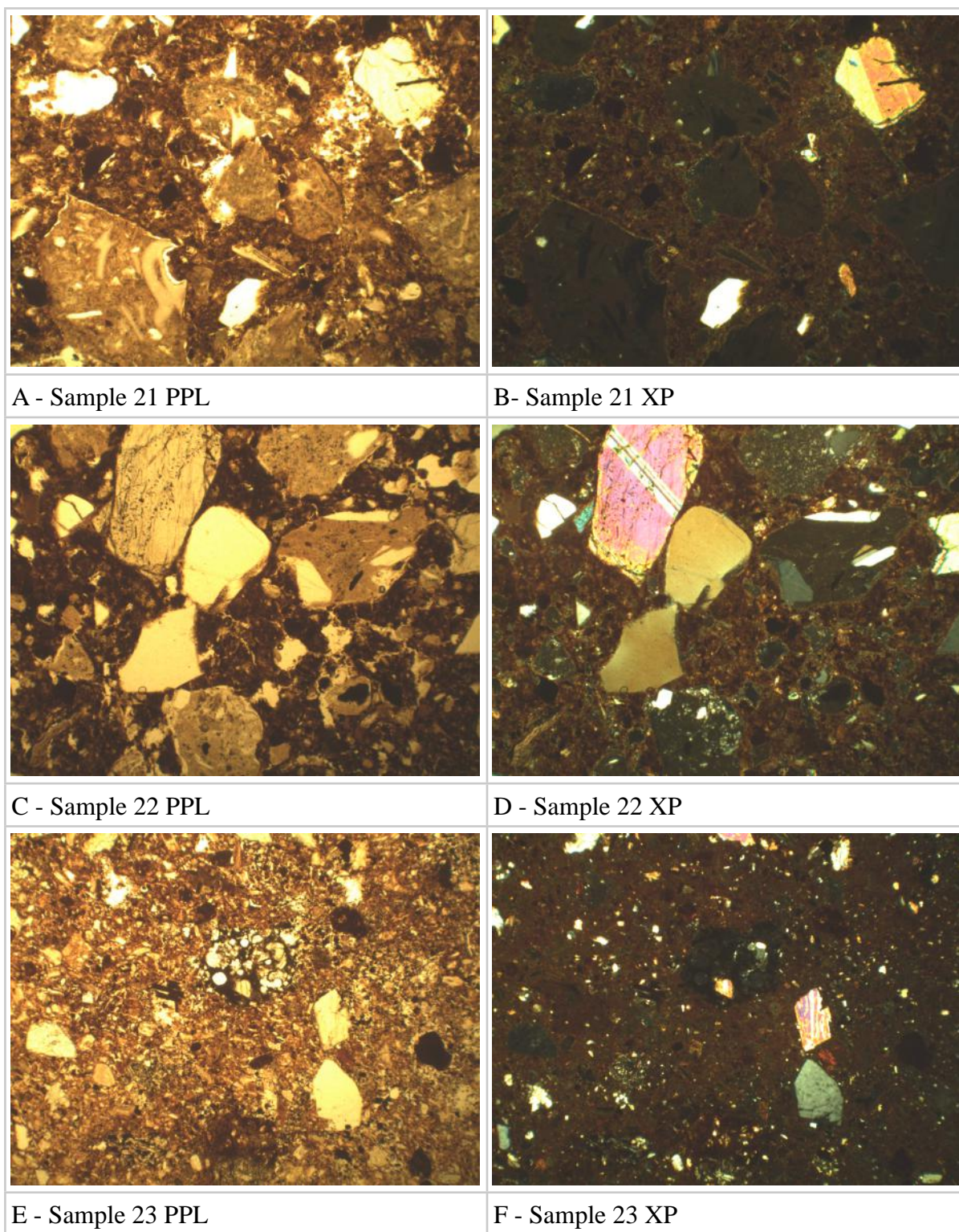


Figure 7. Thin section photomicrographs of Medieval ceramics from Lalibela analyzed in this report. Image width = 2.9 mm. XP = Crossed polars, PPL = Plane polarized light.



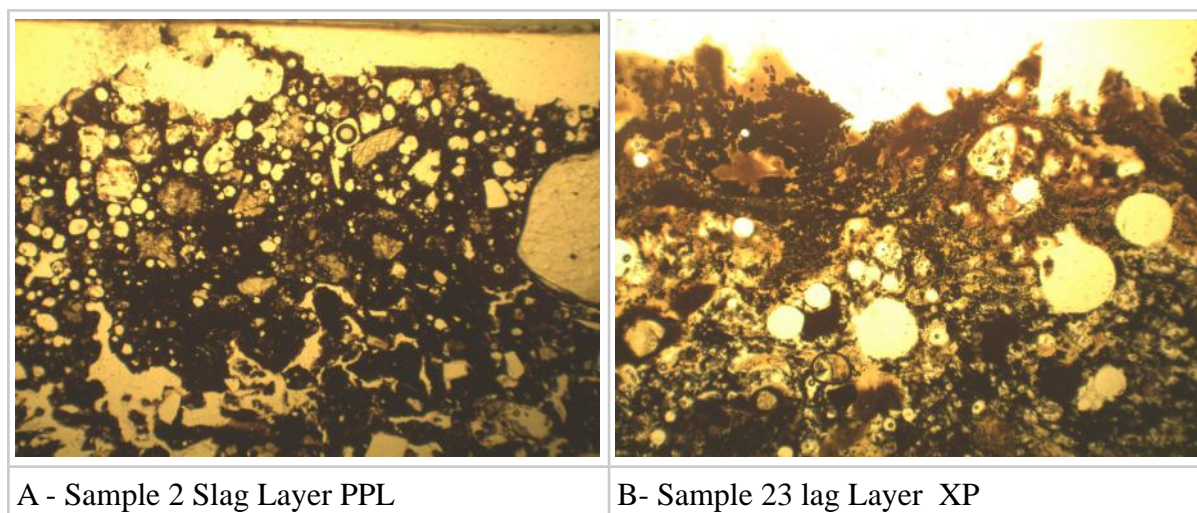


Figure 8. Thin section photomicrographs of Medieval ceramics from Lalibela analyzed in this report. Image width = 2.9 mm. XP = Crossed polars, PPL = Plane polarized light.

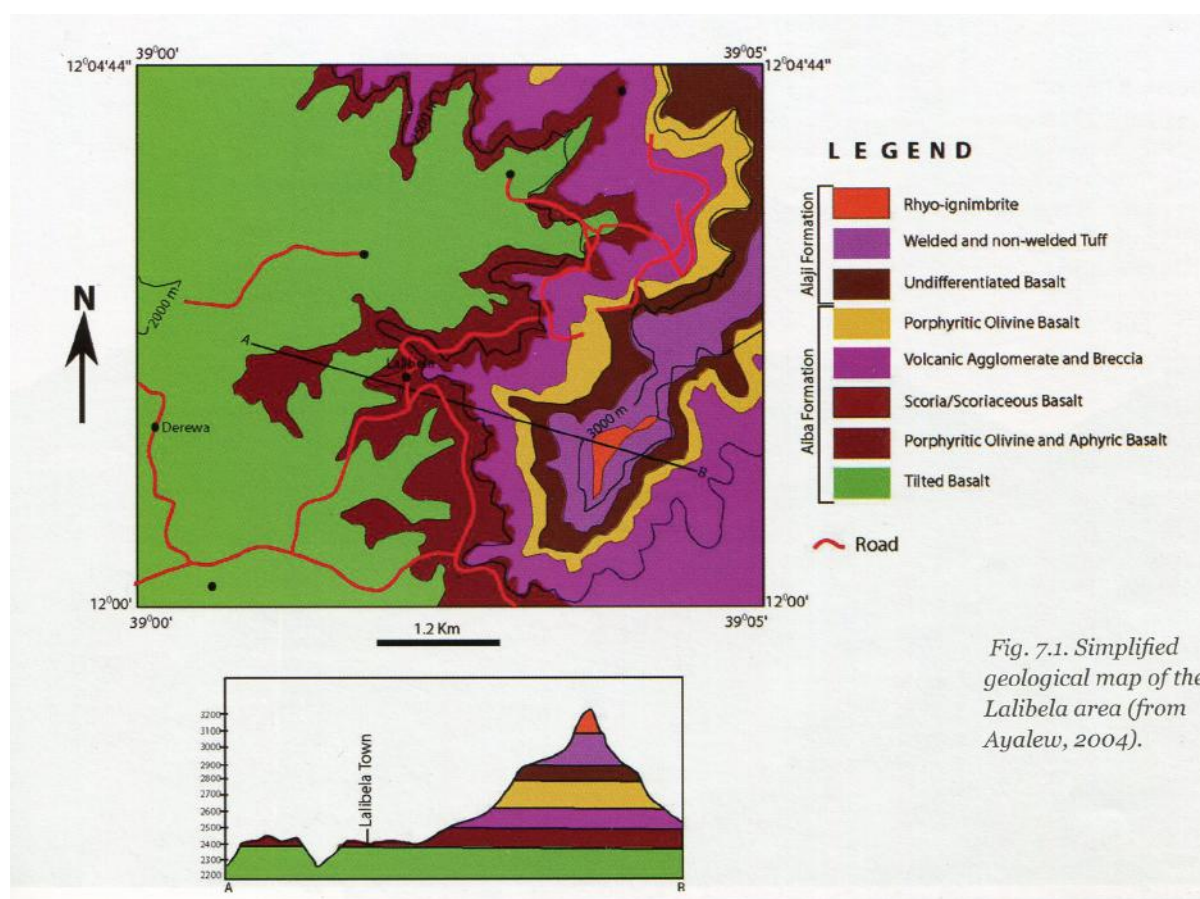


Figure 9. Simplified geological map of Lalibela area.

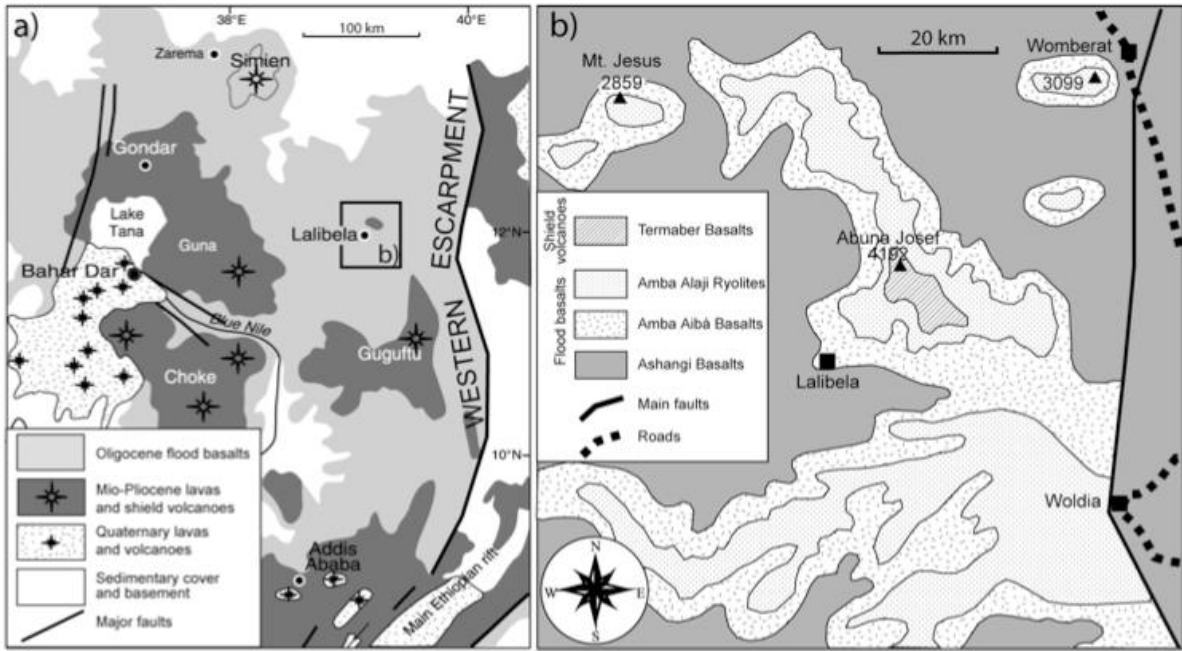


Figure 10. Geological maps of Lalibela and its wider region (from Sani et al. 2012)

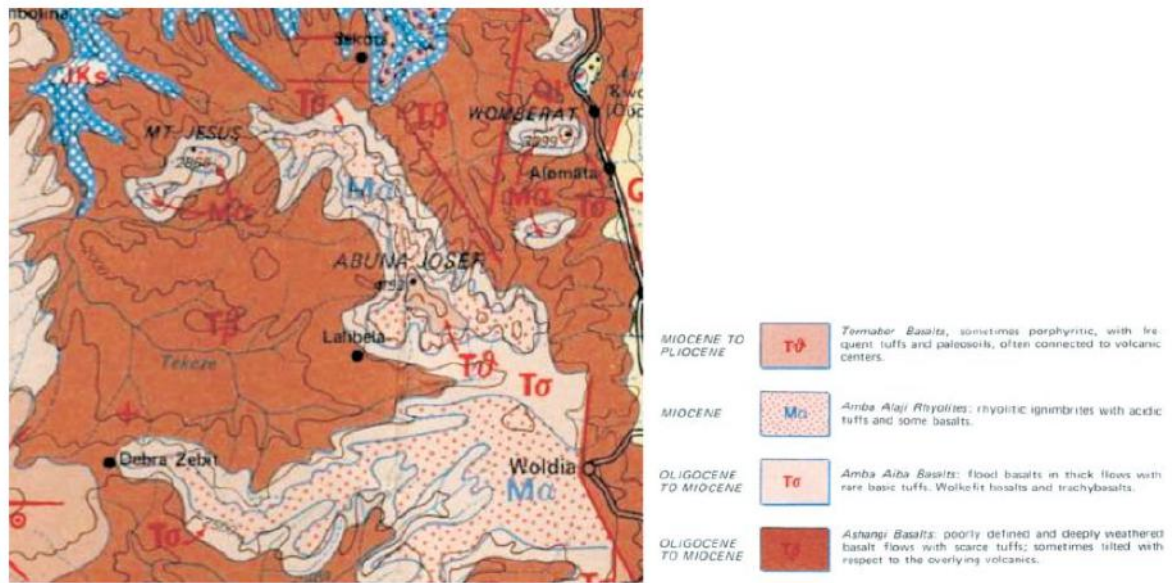


Figure 11. Geological maps of Lalibela and its wider region (from Merla et al. 1979)

## **Appendix G**

### **Metals Inventory**

The following are inventories of metal objects and slag recovered from excavations and slag recovered from surface collection O at Kiflie Mado.

Table G.1. Inventory of metal artifacts recovered from excavations and surface collections

Locus	Description	Quantity	Weight (grams)	dimensions
4008	metal wire	5	3.4	
4008	wound, round-headed nail	1	9.2	52.9 mm Long; 16.5 mm head Diam.; 6.4 mm thick head; 5 mm thick top of shaft
6001	long, squared metal bar	1	7.5	56.5 mm long; 5.9 mm diameter, 5.4 mm wide
6002	metal coil	1	5.3	9 mm high; 6.5 mm wide; 18.1 mm diameter
7001	slag	8	179	
	slag + tuyère	1	15	
7002	slag	16	97.5	
	misc. rusted metal	1	0.3	
7003	slag	6	90	
	burned earth	4	5.5	
8004	metal shaft with flattened end	1	2.7	51.8 mm long; 3.3 diameter; 2.8x4.4 flattened end
SC N: (8,6)	flat rusted metal	1	1.7	15.1 mm long; 11.8 mm wide; 2.8 mm thick

Table G.2. Inventory of slag recovered from surface collection O.

X coordinate	Y coordinate	n=	weight
O	6	5	155.3
K	8	2	49.7
N	14	4	49.8
N	8	4	53.9
M	16	1	7.1
J	24	4	56.2
N	18	3	206.1
N	6	3	142.7
J	18	3	20.4
J	8	16	266
J	22	3	43.7
M	8	6	74.5
J	16	2	43.5
L	14	3	26.8
L	4	5	239.7
Sum =		64	1435.4 gm